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Rural Food (In)security, Out-migration and Remittance Nexus: Evidence from Rural Mid-Hills of Nepal

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Out-migration is a key driver of rural livelihoods in Nepal but may threaten food security through agricultural decline and the loss of household labour. This study examines the relationship between food security, out-migration, and remittance receipt in rural Nepal. Food security was measured using the World Food Programme's Consolidated Approach for Reporting Indicators of Food Security (CARI, 2021), based on primary data from 387 rural households surveyed in 2024. An ordered probit model, complemented by a multinomial endogenous switching ordered probit (MESOP) model, was employed to account for selection bias and estimate treatment and counterfactual effects. CARI estimates indicate that approximately one-fourth of sampled households were food insecure. After model correction, migrant-remitting households were 24% less likely to be food secure and 12% less likely to be marginally food secure, while they were 36% more likely to be moderately food insecure. Counterfactual estimates indicate that if non-migrant households were to migrate and receive remittances, their probability of being food secure and marginally food secure would decrease by 11.10 and 24.25 percentage, respectively, whereas the probability of being moderately food insecure would increase by 35.32 percentage. These findings suggest that migration and remittance do not necessarily improve food security and may impair vulnerability through loss of agricultural labour, irregular or poorly managed remittances, and declining agricultural productivity. Policy interventions should therefore promote remittance investment in productive sectors, secure remittance channels, and agricultural market centers to encourage agribusiness and income-generating activities, thereby strengthening food security in rural Nepal.

Keywords: food security, out-migration, remittance, rural landscape

1. Introduction

Migration is, in general, defined as a movement that crosses a specified political boundary within a country or beyond the country to establish a new place of residence (Toney & Bailey, 2014). Migration is one of the major factors affecting the shift in population dynamics and the distribution of resources in each territory. It plays a significant role in allocating available resources, affecting all areas of human life (social, economic, demographic, environmental, and political), which becomes very complicated to analyse (Hagen-Zanker, 2010). Both domestic (internal) and international outmigration have become common phenomena in Nepal. Internal migration in Nepal is due to in-country uneven allocation and distribution of resources, poverty, geographical variability, etc., creating the migratory behavior of Nepalese individuals from hills to plain areas (Terai) and from rural to urban areas (Kumar, 2004). Hill-to-Terai migration has been driven by factors such as productive agricultural land, plain topography, easy access, and developed infrastructure, while a lack of arable and fertile land, uneven topography, and limited infrastructure are the major push factors (Kumar, 2004; Kunwar, 2017). International migration has occurred for labor migration to Gulf countries and Malaysia and cross-border migration between Nepal and India due to the open border between the two countries (Bhattarai et al., 2023). Recently, a larger portion of international migration in the form of skilled manpower, better job and education opportunities, and facilities in European & American countries and Australia has also pulled youth out of Nepal (Kattel & Sapkota, 2018).

Food security is a comprehensive condition explained in different ways by international organizations and researchers, depending on the context and requirements of their study. The recent and widely recognized definition of food security is “the extent all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1996). The FAO’s definition of food security involves four main aspects or dimensions: availability, access, utilization, and stability. All these dimensions are equally essential as instruments for food security analysis for better targeting and evaluating public policy interventions (Maxwell et al., 1999). Considering the factors contributing to food insecurity, designing and implementing programs related to livelihoods and food security is straightforward, but measuring household-level food security in a precise and efficient manner is still challenging (Regmi et al., 2019). Food insecurity is considered a key driving factor for people to migrate (WFP, 2017a). Outmigration has become one of the strategies used by a household to address food insecurity risks and income uncertainties (Sadiddin et al., 2019). Recent studies have indicated that remittances help address household economic shocks for low-income households and help reduce poverty, enhance food security, lead to reduced hunger, a better diet, and induce on-farm investment along with human development in developing countries such as Nepal (Gaudel, 2016; FAO, 2013). Some studies have shown that the impact of remittances is obvious in the rural and resource-poor households and communities of developing countries (Adams & Page, 2005; Yang, 2011; Carletto et al., 2011). It has also been suggested that households receiving remittances are more food secure than households that do not receive such remittance income (Regmi & Paudel, 2017). However, a recent study in Ghana suggested that most migrants, regardless of receiving remittances, were found to be moderately to severely food insecure (Armah et al., 2025). Research on international remittance and household food security in Sub-Saharan Africa suggests that such remittances are important for improving household food security;

however, the frequency of remittances received by left-behind people is more important for stable food security status (Sulemana et al., 2019).

This study uses a primary survey of 387 rural mid-hill households comprising non-migrant and migrant households to illustrate the impact of migration and remittance characteristics on the food security status of the rural hills of Nepal. As some empirical studies have suggested, migration and remittances have assisted in reducing poverty and enhancing food security (Pyakuryal et al., 2010) but still have not yet been researched in the rural context of Nepal, to determine the effects of migration and remittance characteristics on rural household-level food security status. To address food insecurity at the rural household level, some policies need to be considered, as migration is an increasingly important livelihood strategy and a potential tool to improve household-level food security (Sadiddin et al., 2019). The nexus among rural out-migration, remittances, and food security in the Nepalese context, which focuses on the rural landscape, has received less attention from the academic literature. Therefore, this research focuses more on analysing the impact of out-migration on rural households' food security status. More importantly, we use the Consolidated Approach for Reporting Indicators (CARI) (WFP, 2021) to assess the food security situation of rural households. Thus, we examine rural household-level food security status by calculating the food consumption score (FCS), reduced coping strategies index (RCSI), food expenditure share (FES), and livelihood-based coping strategies-food security (LCS-FS). We prepare a CARI domain (food secure, marginally food secure, moderately food insecure, and severely food insecure) on the basis of the parameters estimated. We analyse the impacts of migration and remittance characteristics on the household food security situation according to the CARI domains. Therefore, this study represents a noble step toward connecting the following relationships with the global development agenda: migration, remittance, and household-level food security in the rural landscape of Nepal.

2. The Nepalese Context of Food Security

Over the past decade, the world has faced a global pandemic, an economic downturn, increasing regional conflicts, and severe climate shocks, all of which have been leading causes of global food insecurity (FAO et al., 2025). Food insecurity was higher among households dependent on agriculture, especially smallholder farmers, than among households engaged in non-farm activities (Kogan et al., 2019). Smallholder farmers are more vulnerable to food insecurity because they rely heavily on agriculture for their income and livelihoods (Ado et al., 2019). Increasing food insecurity in agriculture-dependent countries is due to climate extremes, population growth, and changing lifestyles (WB, 2022). The Nepalese farming system is predominantly occupied by smallholders, who are characterized by high levels of poverty and food insecurity (Gartaula et al., 2017; Thapa & Hussain, 2021). Food insecurity is becoming a daily problem, particularly for households in remote areas of the country (Pandey & Bardsley, 2019; Randell et al., 2021). Access to food for all citizens is a fundamental right in Nepal (GoN, 2015), yet the country ranks 74th in terms of food insecurity (The Economist Group, 2022). The affordability, quality, safety, and sustainability of food are low among rural households living under poor socio-economic conditions (The Economist Group, 2022). Nepal is now becoming the net importer of food grains and fruits, so highly dependent on imported food (about 21 %), mainly from India and neighbouring countries (Adhikari et al., 2021). Smallholder farmers in Nepal's rural mountain, hill, and Terai regions are more vulnerable to food insecurity than in urban areas (Pandey &

Bardsley, 2019). This is due to limited access to modern agricultural technology, infrastructure, markets, and financial services, adverse climatic conditions, and higher dependency on rain-fed agriculture (Adhikari et al., 2021; Karki et al., 2020). However, agricultural production and productivity in the country's remote mountainous and hilly regions are critical to food security (Randell et al., 2021). Recently, the effects of the COVID-19 pandemic, the series of economic shocks due to the war in Ukraine and the Middle East, have increased food prices and destabilized the existing global, regional, and national food systems (WFP, 2024). This threatens economic access to food for the most vulnerable regions. These aspects, along with the impact of localized shocks, are contributing to a slight deterioration of food security in Nepal, ultimately hampering Nepal's ability to achieve the zero hunger targets under Sustainable Development Goal (SDG) 2 (WFP, 2024).

3. Theoretical Background of the Study

Globally, rural depopulation has reshaped the pattern of agricultural land use and efficiency, ultimately altering the rural food security situation (Karki et al., 2021). Migration studies are interdisciplinary or even transdisciplinary (Scholten et al., 2022), driven by a complex combination of macro-level (political, demographic, socio-economic, and environmental situations), meso-level (migration networks, institutions, geography), and micro-level (individual, households) (Castelli, 2018; Czaika & Reinprecht, 2020) drivers. Nepal is experiencing social, cultural, and economic transformation due to remarkable changes in out-migration trends, agricultural land use changes, and food security dynamics (Jaquet et al., 2019). Nepalese out-migration, whether internal or international, is a family decision that affects every member of the household (Bodvarsson et al., 2015), due to strong family ties (Monteiro, 2022). We take the household as the unit of analysis and the household head as the primary respondent who provides information on the migrants' household members. Household members often decide upon migration collectively to improve household welfare through remittance (Maharjan et al., 2013; Shattuck et al., 2019; Wagle & Devkota, 2018).

Additionally, the connection between rural development and land use changes has been examined through different lenses (Zhu et al., 2020). Besides, alterations in rural agricultural land use morphologies is closely linked with grain production, rural out-migration, and rural industry development, etc. (Drummond et al., 2017; Zhu et al., 2020), which are consistently associated with the pattern of land use in rural areas. Along with the connection between rural outmigration and cropland utilization decisions, many development partners and researchers in the past decades have argued that outmigration helps to enhance the food security of households at the place of origin by providing financial support for food purchase and agricultural intensification (Craven & Gartaula, 2015). This research also attempts to theorize the migration and development studies that shape migration decisions, processes, and outcomes, which are very complex (de Haas, 2011, 2021; King, 2012; Skeldon, 2002). We conceptualize the migration-food security nexus study through the combination of 2 approaches: Push-Pull Plus and Aspiration Capabilities. The traditional push-pull framework of migration has been criticized due to a laundry list of factors without any rigorous analytical aspects. The modified push-pull plus framework (Van Hear et al., 2018) suggests that drivers of migration are categorized into individual components and examines the relationship between each component, viz., predisposing, proximate, precipitating, and mediating drivers. Van Hear et al. (2018) suggest that the drivers and dimensions of migration lead to functional and dimensional interdependence, which creates a driver complex in shaping the decision to migrate and

migration dynamics. Firstly, we use this theory to conceptualize the interaction between push and pull factors and the notion of the driver concept. Secondly, it helps to identify a nuanced understanding of the link between migration & food security and determinants of food security in the rural landscape of Nepal. Although the aspiration capabilities framework does not speak about food security, it is important to conceptualize how the aspirations and capabilities of potential migrants impact household food security by understanding the aspirations of migrants that migrants can create reliable access to food and improve the quality of life of those left behind in the place of origin. Within this theoretical background, we consider how migration characteristics (non-migrants, migrant-without-remitting, and migrant-remitting) influence household food security in the rural mid-hills of Nepal.

The rest of the paper is organized as follows. The next section describes the methodological approach: study site, data and survey design, calculation of the CARI domain and migration, and econometric specifications. The following section describes the general findings and econometric results with a discussion. The last section summarizes the results and concludes.

4. Methodological Approach

4.1 Study Site and Survey Design

The qualitative and quantitative assessment of migration characteristics and food security status was conducted in two rural municipalities (RMs), Gajuri from Dhading district, Bagmati Province, and Bhisenthapa from Gorkha district, Gandaki Province (Figure 1). We purposively selected these rural municipalities, as both municipalities have experienced both internal migration (internal migration to Kathmandu and Chitwan) and labor migration to Gulf countries; both municipalities are located in the rural mid-hill region with limited arable land and thus rely heavily on market-based food access. In contrast, recently, Gajuri RM has implemented a foreign aid agriculture development project (Food and Nutrition Security Enhancement Project, funded by the World Bank) and is adjoining the Prithvi Highway, but Bhimsenthapa RM has not implemented any foreign aid agriculture development project and is located relatively more remote from major market hubs, relying more on secondary rural roads. To capture these ecological, socioeconomic, and geographical characteristics, we chose these two rural municipalities for the study, with a focus on rural outmigration and its impact on food habits and food security status within a household.

The sample size was calculated via the following Cochran's formula (Heinisch, 1965) for a known population size. The details of the sample size calculations are summarized in Table 1.

$$n_0 = Z^2 pq / e^2$$

where

n_0 = the sample size;; Z = the selected critical value of the desired confidence level; e = the desired level of precision; p = the estimated proportion of an attribute that is present in the population; $q = 1 - p$.

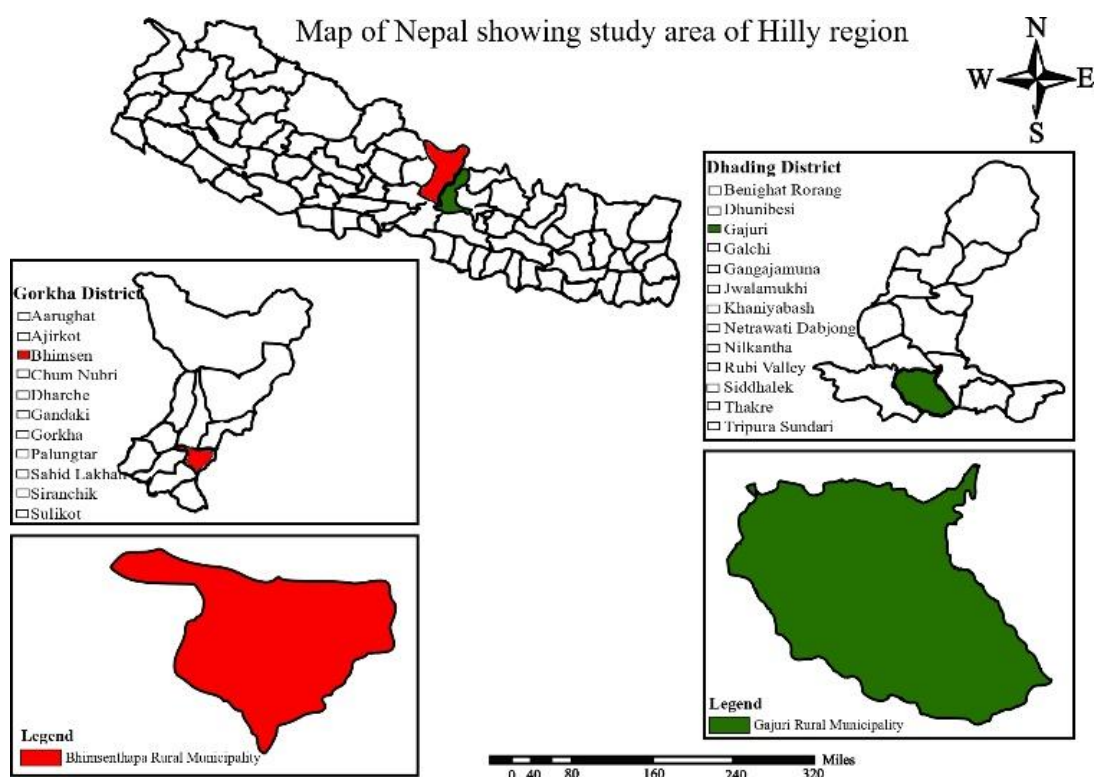


Figure 1: Map showing survey areas in the rural municipalities of Bhimsenthapa and Gajuri.

Table 1: Sample size determination, districts and rural municipalities for the survey

SN	Province	Total migration	Migration by Marriage	Migration except marriage (Total population size)	Total sample size(=n)	Migrant sample (Experimental group:n1)	Nonmigrant sample (Control group: n2=)	District	Rural Municipality
1	Bagmati	2775386	625295	2,150,091	97	107	85	Dhading	Gajuri
2	Gandaki	889099	287422	601,677	97	122	73	Gorkha	Bhimsenthapa
Total Sample size						229	158		

Note: Population size Kn (N), precision level= +/-10%, confidence level= 95%, population proportion= 0.5%, and nonresponse rate= 15%. Source: (NPHS, 2022) and the authors' calculations.

A cross-sectional research design was applied to conduct a household survey through a semi-structured questionnaire. A total of 229 migrant households and 158 non-migrant households were interviewed from November–December 2024, which is slightly greater than the calculated sample size to consider the possibility of nonresponse. A semi-structured survey questionnaire was developed using the WFP-CARI approach as a corporate tool to measure and assess the food security situation. This tool allows us to assess different dynamics of food security situations and determine the prevalence of food security, such as mild, moderate, and severe food insecurity. A waiver letter for

ethical review was approved by the University, Department of Agricultural Economics considering the collected information was not sensitive and no personal data was gathered during this study. So, an official ethical review was considered unnecessary. Also the participation of the respondent was voluntary and informed consent was taken from all the respondents included in this study.

Community-level focus group discussions (FGDs) and key informant interviews (KIIs) were conducted in each municipality to validate the collected information. The qualitative data provide basic information regarding the leftover members of migrants, along with the overall conditions of food availability, access, and utilization status in the survey areas. Additionally, secondary data from the Nepal Living Standard Survey, 2022/23, National Population and Housing Census, 2021/21, FAOSTAT, World Bank, IOM, and other published documents were used as additional information about the research. The collected data were analysed via STATA (version 18.0).

4.2 Calculation of the food security index through the CARI approach:

The consolidated approach for reporting indicators of food security (CARI) developed by the World Food Programme (WFP) was used for the calculation of food security indicators (WFP, 2021) of the targeted household. The CARI is an approach used by the WFP to aggregate different food security indicators into one index to report the population's overall food security status, summarize it in a table, and distribute the percentage of the population for each indicator on the basis of a specific cut-off point. We want to use this approach because its unit of analysis is the household, so it helps analyse the primary data for a single household according to their level of food security and supports reporting and combining food security indicators systematically and transparently. This approach explicitly classifies households into four descriptive categories—food secure, marginally food secure, moderately food insecure, and severely insecure—and provides representative estimates of food security within the target population. The two dimensions, i.e., the current status of household consumption and coping capacity through economic vulnerability and livelihood coping strategies, were assessed via a selection of four indicators via a specific formula to determine the final food security outcome for each household. The CARI structure used for the analysis of the food security index of each surveyed household is summarized in Table 2.

Table 2: CARI structure for final food security outcomes for each household.

Domain		Indicator		Food Secure	Marginally Food Secure	Food Moderately Insecure	Severely Insecure	Food
Current Status	Food Consumption	Food Consumption Score (FCS)	Acceptable			Borderline	Poor	
			Reduced Strategies (RCSI)	Coping Index	<4	>4		
Coping Capacity	Economic vulnerability	Food expenditure Share (FES)	<50%	50-65%	65-75%	>75%		

Domain	Indicator	Food Secure	Marginally Food Secure	Food Insecure	Moderately Food Insecure	Severely Insecure	Food
Asset depletion	Livelihood Coping Strategies - Food Security (LCS-FS)	None	Applied strategies	stress	Applied crisis strategies	Applied emergency strategies	

Source: (WFP, 2021)

The household food security index is taken from a procedure based on simple averaging using a 4-point scale obtained for each indicator. The ranking of each household is based on a simple average of the current status score and coping capacity score. The households classified as food secure, marginally food secure, moderately food insecure and severely food insecure were assigned scores of 1, 2, 3, and 4, respectively. The details of the CARI reporting table and final product of the CARI method constructed from standard WFP indicators are summarized in Table 2 (See Appendix 1).

4.3 Measuring Migration Characteristics

To address the measurement of migration, first, this study uses two different types of households: non-migrant households and migrant households. Second, among migrant households, we calculate migrants without remittance-receiving households and migrants with remittance-receiving households. The non-migrant households used as a reference group are the normal households that have neither migrant members nor receive remittances. Migrant households are considered to have at least one household member who migrated within the past 6 months, but if the migrant member does not remit at least once a year to their families, they are considered migrant-remit-non-receiving households, and if they do remit, then they are treated as migrant-remit-receiving households.

4.4 Empirical Model and Variables

As household food security status is the outcome variable, it is affected by socioeconomic factors, farm factors, institutional factors, and other unobserved factors. We use the migration-remit-status of the household as a major explanatory variable. The socioeconomic characteristics of the households revealed that the average age of the household head was 46 years, with 67% of the household heads being male and only 4.64 years of schooling. The average distances to the nearby market and the nearest motorable road were 5.96 km and 1.49 km, respectively. Thirty-nine percent of the respondent households were from the higher caste, with a household size of 6.27, and the number of economically active members per household was 4.39. The farm characteristics revealed that 59% of the respondents had access to agricultural land, with an average landholding size of 0.1 Ha only, and the livestock standard unit per household was also only 1.42. Seventy-one percent of households have some sort of food stock, with an average production of agricultural commodities of 1.37 Mt per year. Seventy-seven percent of the households had access to credit, with 48% of the households in the foreign aid agricultural/livelihood project implementation area. A descriptive summary of the outcomes, major explanatory variables, and other control variables is presented in Table 3.

We applied an ordered probit model with robust standard errors to estimate the impact of rural out-migration and remittance characteristics on household-level food security status. We used the four ordered levels of food security status indicated by the CARI approach (WFP, 2021) in Table 2, which are discrete but ordinal in nature. Household food security status was coded as 1 for food secure, 2 for marginally food secure, 3 for moderately food insecure, and 4 for severely food insecure.

Table 3: Description of major variables used in the ordered probit and MESOP estimation.

Variable	Description of variables	Mean	Std. dev.	Min	Max
Outcome variable					
CARI_FES	Classification of household food security status (food secure=1, marginally food secure=2, moderately food insecure=3 and severely food insecure=4) using CARI approach	2.11	0.62	1.00	4.00
Major Explanatory variable					
migration_remit_status	Migration status of a household (non-migrants=1, migrant-no-remit-receiving=2, migrant-remit-receiving=3)	2.00	0.90	1.00	3.00
Control variables					
gender_hh_dummy	Gender of household head (HHH) (Male=1, otherwise=0)	0.67	0.47	0	1
Age_HHH	Age of household head in years	46.29	13.30	17.00	85.00
Family_type_dummy	Type of family (Joint=1, Nuclear=0)	0.57	0.50	0	1
Total_school_yrs_HHH	Total schooling years of HHH	4.65	4.87	0.00	18.00
Highest_edu_women_years	The highest schooling year of a female member of HH	9.03	4.76	0.00	18.00
Dist_nearby_market	Distance to nearest market in Kilometres (km)	5.96	4.68	0.50	35.00

Variable	Description of variables	Mean	Std. dev.	Min	Max
Dist_near_motorable_road	Distance to the nearest motorable road in km	1.49	5.10	0.00	92.00
high_caste	Higher ethnical group (Brahmin/Chhetri as higher caste=1, otherwise=0)	0.39	0.49	0	1
HH_size	Size of household in number	6.27	3.23	1.00	22.00
eco_active_mem	Economically active member (15 to 64 years of age)	4.39	2.42	0.00	22.00
LSU	Livestock Standard Unit (1 cow=1 buffalo=10 sheep/goat=33 chickens)	1.42	2.72	0.00	32.00
land_size_Ha	Average land holding of a Household in hectares	0.10	0.26	0.00	1.68
access_agriland	HH having access to agriculture land (Yes=1, otherwise=0)	0.59	0.49	0	1
food_stock_dummy	HH having food stock for future (Yes=1, otherwise=0)	0.73	0.44	0	1
agri_prod_mt	Total Agriculture production last year (Mt)	1.37	4.05	0.00	40.00
access_credit_dummy	Access to credit (Yes=1, No=0)	0.77	0.42	0	1
Foreign_aid_project_dummy	Implementation of any foreign aid agriculture/livelihood project last year (Yes=1, No=0)	0.48	0.50	0	1
mig_network_dummy	Migration networks of migrants as their extended family members, relatives, or close friends who migrated in the past (Yes=1, No=0)	0.63	0.48	0	1

Note: Number of observations=387; Source: Field Survey, 2024 and authors' calculations

We use the food security status definition as defined by the CARI approach (WFP, 2021) as follows:

- Food security (1): The ability of a household to meet food needs without engaging in reduced and livelihood-coping strategies for food security.
- Marginally food secure (2): Having minimally inadequate food consumption, relying on reduced coping, and applying stress coping strategies to secure food needs.
- Moderately food insecure (3): Households have food consumption gaps and are unable to meet the required food needs without applying crisis coping strategies.

- d. Severely food insecure: Households with extreme food consumption gaps or extreme losses of livelihood assets leading to food consumption gaps, or worse.

We also categorized the major explanatory variable, the outmigration and remittance characteristics as nominal variable: non-migrant (1), migrant-non-remittance receiving (2), and migrant-remittance receiving (3), which is the variable of interest. Other factors are considered control variables. The underlying latent regression model is as follows (M. Regmi & Paudel, 2017):

$$HFS_i^* = \beta X_i + \varepsilon_i \dots\dots\dots(1)$$

where X_i represents a set of K observable household characteristics, β is a vector of regression parameters to be estimated for K different characteristic variables, and ε_i is the stochastic disturbance term. The n sample observations are labelled $i=1.., n$. HFS_i^* is the ordered categorical variable for the household-level food security status, which is related to a latent variable HFS_i^* as follows:

$$HFS_i = \begin{cases} 1 & \text{if } HFS_i^* \leq \mu_1 \\ 2 & \text{if } \mu_1 < HFS_i^* \leq \mu_2 \\ 3 & \text{if } \mu_2 < HFS_i^* \leq \mu_3 \\ 4 & \text{if } \mu_3 < HFS_i^* \end{cases} \dots\dots\dots(2)$$

The out-migration-remittance characteristic is assumed to be an endogenous explanatory variable for different food security statuses, given that reverse causality may arise, with food insecurity pushing a household member to migrate (WFP, 2017b). In particular, migration and remittances may affect food security; at the same time, food-insecure household members may decide to move elsewhere in search of additional income to become food secure. So, estimation of food security using ordered probit may result in an inconsistent maximum likelihood estimator, as simultaneous correlation between regressor and error terms exists. So, we estimate an Instrumental variable (IV) ordered probit regression using a multinomial endogenous switching ordered probit framework that evaluates the impacts of endogenous multiple selection choice of migration-remit status on an ordered outcome, viz, food security status, which is fundamentally a two-stage structure consisting of a multinomial selection equation and regime-specific ordered outcome equations. To create the instrumental variable, we use dummy variables for migration networks of migrants as their extended family members, relatives, or close friends who migrated in the past (Regmi & Paudel, 2017). Much of the literature regarding migration studies recognizes “migration network” as one of the key factors motivating migration. Information on historical migration rates, community-level migration networks, and access to migration networks were widely used instruments by many authors regarding the migration and remittance study (Adams & Cuecuecha, 2010; Brown & Leeves, 2011; Hu, 2013; M. Regmi & Paudel, 2017; Taylor et al., 2003). The assumption is that households with a migration network can provide essential information regarding the migration benefits, so they are assumed to directly benefit but do not directly alter the food security situation of the household. Kandel et al. (2026) estimate the impact of rural out-migration on food security in Nepal by applying a probit model with endogenous switching regression. Biru et al. (2020) also estimate the impact of agricultural technologies on poverty and vulnerability of smallholders in Ethiopia using two-stage endogenous switching multinomial regression.

By following Biru et al (2020) & Kandel et al (2026), we conceptualize our multinomial endogenous switching ordered probit framework as follows:

Stage one: Multinomial selection

Let a household decide the discrete choice of migration-remittance regime; M_i from three mutually exclusive categories ($i=1,2,3$):

$$M_i \in \{1,2,3\}$$

$M_i=1$: Non-migrant households as base category (Regime 1)

$M_i=2$: migrant-non=remitting households (Regime 2)

$M_i=3$: migrant-remitting households (Regime 3)

The latent utility function for regime-specific choice is expressed as:

$$M^*_{ij}=Z_i\gamma_j+\varepsilon_{ij} \dots\dots\dots (3)$$

Where,

Z_i = vector of explanatory variables influencing migration-remittance choice, γ_j = parameter vector, ε_{ij} = stochastic error term.

The Probability that the household i chooses the migration-remittance regime j is estimated through a multinomial logit model expressed as:

$$P(M_i=j) = \frac{\exp(Z_i\gamma_j)}{\sum_{k=1}^J \exp(Z_i\gamma_k)} \dots\dots\dots (4)$$

The first-stage model includes vectors for all explanatory variables. In the multinomial logit model as expressed in equation (4), the parameters should be estimated consistently and without bias, assuming the independence of irrelevant alternatives (IAA) holds. Furthermore, the IAA assumption requires that the probability of a household's characteristics influencing certain migration-related decisions be independent of the probability of choosing another decision. The principle of IAA assumes that the disturbance term in the basic model, as in equation (4), is independent and homoscedastic (Deressa et al., 2009). After considering the IAA assumptions, the predicted probabilities from these multinomial regressions are used to derive selection correction terms.

Stage 2: Selection Correction Terms:

From the multinomial endogenous switching framework, three regime-specific selection correction terms (i.e., $\lambda_1, \lambda_2, \lambda_3$ are the inverse Mills ratios) are computed to control for non-random selection from the predicted multinomial logit probabilities as follows:

$$\lambda_j = \ln(P_j) + \sum_{k \neq j} \left(\frac{P_k \ln P_k}{1 - P_k} \right) \dots\dots\dots (5)$$

Where, $P_j = P(M_i = j)$

The estimated correction terms (i.e., $\lambda_1, \lambda_2, \lambda_3$) are included in the second-stage outcome equations to correct the endogeneity bias.

Stage 3: Regime-specific ordered probit outcomes:

As we measure the food security status of the rural household using the Consolidated approach for reporting indicators of Food Security with four ordered outcomes as 1= Food secure; 2= Marginally food secure; 3= Moderately food insecure; 4= Severe food insecure

We merge the severe food insecure outcome to Moderately food insecure as the observations are insufficient for this outcome category.

Thus, the latent food security equations for each migration-remittance regime would be;

$$Y_{ij}^* = X_i\beta_j + \sigma_j\lambda_j + u_{ij} \dots\dots\dots (6)$$

where:

Y_{ij}^* = latent food security outcome, X_i = explanatory variables, β_j = regime-specific coefficients, λ_j = selection correction term, and u_{ij} = error term

Finally, the food security outcomes are generated by the following thresholds:

$$HFS_i = \begin{cases} 1 & \text{if } HFS_i^* \leq \mu_1 \\ 2 & \text{if } \mu_1 < HFS_i^* \leq \mu_2 \\ 3 & \text{if } \mu_2 < HFS_i^* \\ 4 & \text{omitted due to outcome limitation} \end{cases} \dots\dots\dots (7)$$

Where, μ_1 and μ_2 represent estimated cut points.

Stage 4: ATT (Average Treatment Effect on the Treated) & ATU (Average Treatment Effect on the Untreated) Calculation:

We calculate the average treatment effect on the treated & average treatment effect on the untreated by using the following regime specific categories:

For treatment regime j relative to benchmark k :

$$ATT_{jk} = E(Y_j | D = j) - E(Y_k | D = j) \dots\dots\dots (8)$$

For untreated regime k :

$$ATU_{jk} = E(Y_j | D = k) - E(Y_k | D = k) \dots\dots\dots (9)$$

Additionally, we compared three specific regimes, i.e. Regime 3 versus 1 (ATT_{21}, ATU_{21}) Regime 3 versus 1 (ATT_{31}, ATU_{31}) and Regime 3 versus 2 (ATT_{32}, ATU_{32}) to critically analyze the migration-remittance effects on food security.

5. Results & Discussion

We have the outcome variable as the household-level food security index as the dependent variable and outmigration-remittance characteristics as the major explanatory variable in the regression model. Among the 3 categories of outmigration-remittance characteristics, we use non-migrant households as a reference group for inference. We interpret the coefficients of the regression by computing the partial changes in the marginal probabilities of an outcome for a given change in each of the independent variables. The computed marginal effects showed the probabilities of having food secure, marginally food secure, moderately food insecure, and severe food insecure.

5.1 Food security status of the study area via the CARI approach

The details of the food security indicators, i.e., the food consumption score (FCS) with the reduced coping strategies index (rCSI), maximum coping behaviour (Livelihood-based coping strategies-Food security (LCS-FS)), food expenditure share (FES), and overall household food security status calculated via the CARI approach, are summarized in Tables 4, 5, 6, and 7 (*see also Appendix 2*). The food consumption score (FCS) revealed that more than 75% of the households had an acceptable food consumption score, with only 1.29% acceptable, with a reduced coping strategy index of less than 4. However, 17.57% of the households were categorized as having borderline food consumption, and 6.98% had poor food consumption. The food consumption score (FCS) of the household with a reduced coping strategies index (rCIS) is summarized in Table 4.

Table 4: Food consumption score (FCS) with the reduced coping strategies index (rCSI)

Categories	Frequency	Percentage
Acceptable	287	74.16
Acceptable and rCSI>4	5	1.29
Borderline	68	17.57
Poor	27	6.98

Source: Field Survey, 2024, and authors' calculations via the CARI approach.

The maximum coping behaviour calculated from livelihood-based coping strategies—food security (LCS-FS)—showed that more than 92% of the households did not adopt any coping strategies, 5.94% adopted stress coping strategies, and very few households adopted crisis (1.29%) or emergency (0.26%) coping strategies. The details of the maximum coping behaviour for food security are described in Table 5.

Table 5: Maximum coping behaviour for food security

Categories	Frequency	Percentage
No strategy	358	92.51
Stress	23	5.94
Crisis	5	1.29
Emergency	1	0.26

Source: Field Survey, 2024, and authors' calculations via the CARI approach.

Table 6 presents the share of food expenditure (FES) of the households surveyed. Only 6.72% of the households spent less than 50% of their expenditures on food items. Approximately 11% of the households spent 50% to 65% of the expenditure share on food items, and 13.7% of the households spent 65% to 75% of the expenditure share on food. A remarkable percentage of households (more than 68%) spend more than 75% of their expenditure share on food items, suggesting greater economic vulnerability in terms of food security.

Table 6: Share of food expenditure (FES) of the household

Categories	Frequency	Percentage
<50%	26	6.72
50%-65%	42	10.85
65%-75%	53	13.7
>75%	266	68.73

Source: Field Survey, 2024, and authors' calculations via the CARI approach.

The household food security status calculated via the CARI classification through the food expenditure share is summarized in Table 7. Approximately 75% of the households were at least food secure, with 13.7% food-secure households and 61.76% food-secure households. However, one-fourth of the households were food insecure; the percentage of moderately food insecure households was 24.29%, and less than one percent (0.26%) of the households were severely food insecure.

Table 7: Household food security status according to the CARI Classification with FES.

CARI classification using FES	Frequency	Percent
Food secure	53	13.7
Marginally food secure	239	61.76
Moderately food insecure	94	24.29
Severely food insecure	1	0.26
Total	387	

Source: Field Survey, 2024, and authors' calculations via the CARI approach.

5.2 Empirical Results

5.2.1 Ordered Probit Estimation and Model Correction

The three migration characteristics (non-migrants as the reference group, migrant- non-remitting, and migrant-remitting) of a household as categorical variables are used to determine the overall food security status (food secure, marginally food secure, moderately food insecure, and severely food insecure). Firstly, the coefficients and marginal effects from an ordered probit regression with robust standard errors for household food security are derived (Annex 2). Before discussing the results and implications of the model estimates, we resume instrumental variable techniques to identify the impacts of migration characteristics on food security; the corrected model addresses endogeneity and reverse causality, as not only do migration characteristics influence food security, but at the same time, the food-insecure households may be willing to let more members migrate to ensure food security. To address this issue, we

consider the Multinomial Endogenous Switching Ordered Probit Regression (MESOPR) Estimation, as specified in Section 4.4.

We first calculate the multinomial selection coefficient (Appendix 4), which includes the vectors of all explanatory variables. Since estimation from a multinomial logit model might be biased and inconsistent, we test the independence of irrelevant alternatives (IIA) assumption, which holds if the relative odds of one outcome remain unchanged when additional alternatives are added or removed. We use three diagnostic tests: the Hausman test, the SUEST-based Hausman test, and the small-Hsiao test to assess whether the IIA assumption holds (Appendix 5). The Hausman statistics showed negative χ^2 values (Long and Freese 2014), indicating that the estimated covariance difference matrix is not positive definite and that the IIA assumptions are violated. The SUEST-based Hausman test statistics across the three regimes failed to reject the null hypothesis (p-values = 0.316, 0.964, and 0.982), indicating that the IIA assumptions hold. Although the small-Hsiao test statistics reject the null hypothesis for two outcome comparisons (regime 1 & regime 2), this may be due to random sample partitioning, particularly for moderate-sized samples. Therefore, we consider the SUEST-based Hausman test statistics as the primary diagnostics for the evaluation of IIA assumptions (Long and Freese 2014; Greene 2018), which support the use of the multinomial logit selection.

Secondly, the inverse Mills ratio (Appendix 4) showed that regime 3 (migrant-remitting households) has statistically significant evidence of positive selection ($\lambda = 0.621$, $p < 0.05$). This substantial selection correction term proves that the endogenous switching ordered probit model is appropriate.

The ordered probit estimation (Annex 3) showed that the migrant/non-remitting households were less likely to be food secure. However, such households were more likely to be moderately food insecure. Likewise, migrant-remitting households were also less likely to be food secure and marginally food secure, but such households were more likely to be moderately food insecure. For the model correction, we employed Multinomial Endogenous Switching Ordered Probit Regression (MESOPR) (see Appendix 4).

5.2.2 Average Treatment Effects (Treated-ATT and Untreated-ATU)

After the statistically significant selection correction terms, the estimate of the ordered probit is assumed to be biased and inconsistent. The significant results of the multinomial switching ordered probit regression are shown in Appendix 4. So, after estimating the selection correction terms, we calculate the average treatment effect on the treated and the average treatment effect on the untreated for food security outcomes with respect to regime-specific categories, as shown in Table 8.

Table 8: Average Treatment effects on food security outcomes

Comparison Regime	Effect	Food Secure	Marginally Food Secure	Moderately Food Insecure
Regime 3 vs Regime 1	ATT ₃₁	-0.24	-0.12	0.36
	ATU ₃₁	-0.11	-0.24	0.35
Regime 3 vs Regime 2	ATT ₃₂	-0.16	-0.12	0.28
	ATU ₃₂	0.00	0.03	-0.03
Regime 2 vs Regime 1	ATT ₂₁	0.02	-0.12	0.10
	ATU ₂₁	0.16	-0.22	0.07

Note:

ATT₃₁- Average Treatment Effects on the Treated (Regime 3 Vs Regime 1)
 ATU₃₁- Average Treatment Effects on the untreated (Regime 3 Vs Regime 1)
 ATT₃₂- Average Treatment Effects on the Treated (Regime 3 Vs Regime 2)
 ATU₃₂- Average Treatment Effects on the untreated (Regime 3 Vs Regime 2)
 ATT₂₁- Average Treatment Effects on the Treated (Regime 2 Vs Regime 1)
 ATU₂₁- Average Treatment Effects on the untreated (Regime 2 Vs Regime 1)
 (Severe food insecure outcome merged to a moderately food insecure outcome due to insufficient observations)

Since the selection correction term (λ) is only significant for ordered probit outcomes of regime 3, we compare the probabilities of being in different food security outcomes of regime 3 with regime 1. The results showed that the migrant-remitting households were 24% and 12% less likely to be food secure & marginally food secure, respectively, but such households were 36% more likely to be moderately food insecure as compared to non-migrant households. Additionally, the migrant-non-remitting households were 12% less likely to be marginally food secure but 10% more likely to be moderately food insecure. The counterfactual results showed that if the non-migrant households do migrate and remit, their probability of being food secure and marginally food secure would be expected to decrease by 11.10 and 25.24 percent, respectively. However, the counterfactual probability of being moderately food insecure would increase by 35 percentage. So, these counterfactual results suggest that there would be a substantial shift towards food insecurity due to migration and remittance characteristics.

Since recent data on Nepalese population dynamics show that 33.9% of the total population still lives in rural areas (NSO, 2021), with 20.27% of the population being below the poverty line, the incidence of rural poverty is still higher than that of urban poverty, which is 24.665% and 18.34%, respectively; the Gini index is 0.3. Such dynamics among rural and urban settlements, along with changes in population structure and migration patterns, influence agricultural systems and food availability and access, which hamper food security indicators in rural areas. As the state of food insecurity has become a global agenda among leaders and policymakers (Abdullah et al., 2019), the most affected countries are developing countries with low income. Poverty and unemployment have become the major causes of out-migration from rural areas, resulting in lower agricultural productivity (WFP, 2017b). A study related to foreign remittance, food security, and nutrition in Nepal and Vanuatu suggested that an increase in outmigration could negatively impact the agricultural sector, leading to a decline in agricultural output and making it more vulnerable and less attractive as a livelihood option (Craven & Gartaula, 2015). Similar studies in sub-Saharan Africa have shown that migration behaviour harms food security (Sulemana et al., 2019), regardless of remittance transfer. Our study revealed that outmigration and remittance characteristics did not contribute to household-level food security in rural areas. Since Nepalese rural out-migration is due more to poverty and economic scarcity, migration becomes a coping strategy for vulnerable households, but higher migration costs, along with the large portion of remittance consumed in the purchase of household food items, are likely erosive and contribute to food insecurity. The loss of family labor with a small landholding size, causing a decline in agricultural productivity, and unskilled migrants, causing inadequate individual income, may lead to considerable food insecurity in rural areas (Thapaliya et al., 2023). The state of food security in the urban landscape of Nepal showed that these areas were comparatively more food secure than rural areas were, with a higher food security status in Terai (plain area) than in hills/mountains (Thapaliya et al.,

2023). Therefore, this study highlights standing debates among leaders and academic researchers about the nexus between migration characteristics and rural household food insecurity; thus, extensive research comparing rural food security, urban food security, and their connection with out-migration and remittance characteristics should be conducted to provide evidence for further inference in the Nepalese landscape.

6. Conclusion

Nepal has experienced massive youth migration during recent decades, likely resulting in a remittance-based economy from an agriculture-based subsistence economy. The out-migration of human resources, low agricultural productivity, and a poorly developed agri-market structure in rural areas can be the leading causes of rural food insecurity in Nepal. We estimate the impact of migration characteristics, i.e., migrant-no-remittance receiving households and migrant-remittance receiving households, compared with non-migrant households, on rural household food security status. Here, the probability of rural food security due to migration characteristics is unfavourable. Since rural families with small farm sizes and limited livestock units do not produce enough food to cover their basic needs, they rely on the market, which is not fully developed, and need an external source to cover the cost of basic needs. Remittance has become the major external source of income for such rural farming families. However, the remittance flow is inconsistent due to poorly managed channels, leading to economic vulnerability for the rural population, which ultimately contributes to rural food insecurity. The uniqueness of this study lies in measuring household food security using the CARI approach and shows that migration and remittance flows do not automatically ensure food security. Rural households may remain food insecure because of the loss of agricultural labor, limited access to agricultural markets, and unequal or insufficient remittance flows. Policy options regarding the productive utilization of remittances with secured channels that can induce investment in agribusiness or other income-generating activities should be prioritized to improve household-level food security in the rural landscape of Nepal.

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APPENDICES

Appendix 1: The consolidated approach for reporting indicators of food security (CARI) domain calculations

1.1 Current Status Domain

We first collect information regarding the adequacy of household food consumption at the time of the survey by using these two indicators.

a. Food consumption score (FCS):

It provides the status of household food consumption. We used this proxy indicator to measure household food access and then classified households into different groups on the basis of the adequacy of food consumed per week before being surveyed. It is obtained through the following formula:

$$FCS = a_i(\text{cereals})x_i(\text{cereals}) + a_i(\text{legumes})x_i(\text{legumes}) + a_i(\text{vegetables})x_i(\text{vegetables}) + a_i(\text{fruits})x_i(\text{fruits}) + a_i(\text{animal})x_i(\text{animal}) + a_i(\text{sugar})x_i(\text{sugar}) + a_i(\text{milk})x_i(\text{milk}) + a_i(\text{oil})x_i(\text{oil}) \dots\dots\dots (1)$$

where

a_i =Weight of each food group (the weight of each food group, food items and their justification according to the CARI approach are shown in Annex 1).

x_i = Frequency of consumption of food (number of days that food group i consumed in the last 7 days just prior to survey)

The score was compared with the predefined thresholds to classify households into food consumption profiles as indicated by the CARI, as shown in the table below:

Table A1: Thresholds for food consumption profiles

Thresholds	Profile	Thresholds taking into account a daily consumption of sugar and oil (7 days per week)
0-21	Poor Food consumption (Poor)	0-28
21.5-35	Food consumption at the limit (Borderline)	28.5-42
>35.5	Acceptable food consumption (Acceptable)	>42.5

Source: (WFP, 2021)

The food groups and their weights are shown in Table A2.

Table A2: Food groups, food items and their weight with justification (CARI approach)

Food Groups (definitive)	Food Items (examples)	Weight	Justification
Meat, Fish & Eggs	Beef, goat, poultry, pork, fish & eggs	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat.
Dairy	Milk, yoghurt, cheese & other dairy products	4	Highest quality protein, source of micronutrients, vitamin A, and energy.
Pulses/ Legumes	Beans, cowpeas, lentils, soy, pigeon pea, peanuts, and/or other nuts	3	Energy dense, high amounts of protein but of poorer quality than animal sources, micronutrients not readily available (due to presence of phytates), low fat.
Staples	Cereals, grains, roots & tubers (e.g., Rice, pasta, bread, sorghum, millet, maize, potato, yam, cassava, white sweet potato, taro, plantain	2	Energy dense and usually consumed in larger quantities. Protein content lower and poorer quality (poorly digested/poorly absorbed/not containing balanced amino acids) than pulses or animal source proteins, and micronutrients not easily absorbable (due to presence of phytates).
Vegetables	Vegetables & leaves	1	Low energy, low protein, no (or low) fat, source of micronutrients.
Fruits	Fruits	1	Low energy, low protein, no fat, source of micronutrients, high in sugar.
Oil	Oil, fat, and butter	0.5	Energy-dense but with low nutritional value (no or lower amounts of other nutrients).
Sugar	Sugar, honey, jam, candy, chocolate, biscuits/cookies, etc.	0.5	Energy dense but with low nutritional value (no or lower amounts of other nutrients).
Condiments	Spices, tea, coffee, salt, fish powder, small amounts of milk for tea.	0	These foods are, by definition, eaten in very small quantities and not considered to add significant nutritional value to the overall household diet and are not considered in the analysis.

Source: (WFP, 2021)

b. Reduced Coping Strategies Index (RCSI)

We used this index to assess and compare the level of stress faced by households due to a shortage of food, which allows us to distinguish between food secure and marginally food secure households. The RCSI was used to measure the behavioral strategies that the household applied when they could not access enough food or when they foresee a decrease in food security within the last 7 days prior to the survey. The household would be food secure if the FCS

was in an acceptable consumption profile with an RCSI of less than 4 and marginally food secure if the RCSI was more than 4. The major strategies and weights of the strategies are shown in Table A3:

Table A3: Major reduce coping strategies and their weights for the calculation of RCSI

Major Reduced coping strategies	Weight	Frequency (number of days from 0 to 7)	Frequency x weight
1. Relied on less preferred, less expensive food	1		
2. Borrowed food or relied on help from friends or relatives	2		
3. Reduced the number of meals eaten per day	1		
4. Reduced portion size of meals	1		
5. Restricted consumption by adults for small children to eat	3		
RCSI			

Source: (WFP, 2021)

1.2 Coping capacity domain

This domain aims to measure a household's resilience to any shocks. We considered the following two dimensions of household coping capacity for this study.

a. Household's food expenditure share

Since it is difficult to generate data on the poverty line and economic capacity to meet essential needs, economic vulnerability was measured by using the household's food expenditure share (FES). This indicator is based on the assumption that when a household has greater expenditures on food than other consumed items/services, the household is more economically vulnerable. This indicator was simply constructed by dividing total food expenditure by total household expenditure.

$$FES = \text{Food_exp_monthly} / (\text{Food_exp_monthly} + \text{noodfood1_exp_monthly} + \text{nonfood2_exp_monthly}) \dots (2)$$

b. Livelihood-based coping strategies—Food security (LCS-FS)

This coping strategy was derived from a series of responses related to household experiences with livelihood strategies due to a lack of food during the 30 days prior to the survey. This is the response to shock as well as hazards depending on the natural, material, economic, human, social, and political assets of households; the level of their production, income, and consumption; and the diversification of income sources and consumption to moderate the shocks that may occur at any time. We considered the following WFP's recommended 10 strategies (4 stress, 3 crisis and 3 emergency responses) to classify the household according to livelihood-based coping strategies according to the local context on the basis of the principle of the most severe coping strategy used by the surveyed household.

Table A4: Strategies used by households for livelihood-based coping strategies

Strategies	Response categories
Reducing expenditure on nonessential items (drink, ceremonies, clothes, meat, sugar, more expensive staple food items etc.)	Stress
Sale of animals (at levels that maintain the sustainability of herds)	Stress
Borrowing food or money	Stress
Sale of nonproductive goods (jewelry, clothes, etc.)	Stress
Consumption or sale of seeds	Crisis
Reduced expenditure on production inputs (fertilizer, veterinary care etc.)	Crisis
Reduced spending on health and education	Crisis
Excessive sale of livestock (breeding stock)	Emergency
Sale for mortgage of productive assets (land, tools, etc.)	Emergency
Recourse to illegal activities (prostitution, theft etc.)	Emergency.

Source: (WFP, 2021)

In the CARI scale, households not using any selected strategies are considered food secure. In contrast, those using at least one of the stress, crisis, or emergency strategies were classified as marginally food secure, moderately food insecure, or severely food insecure, respectively

Appendix 2: Overall Food Security Status

Table 2: Overall Food Security Status of the Surveyed area according to the rural municipalities

District	Rural Municipality	'FCS Categories'			Maximum coping behavior				Food expenditure share categories				CARI_FES			
		Poor	Borderline	Acceptable	Not adopting coping	Stress	Crisis	Emergency	Less than 50%	50% to 65 %	65% to 75%	More than 75%	Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Dhading	Gajuri	3.6%	3.6%	92.7%	85.9%	9.9%	2.6%	1.6%	7.9%	13.1%	19.4%	59.7%	15.1%	76.6%	7.8%	.5%
Gorkha	BhimshenThapa	10.3%	31.3%	58.5%	97.4%	1.5%	0.0%	1.0%	6.2%	7.2%	10.3%	76.3%	11.8%	47.2%	40.5%	.5%
Overall	Overall	7.0%	17.6%	75.5%	91.7%	5.7%	1.3%	1.3%	7.0%	10.1%	14.8%	68.1%	13.4%	61.8%	24.3%	.5%

Note: CARI_FES represents the calculation of food security categories according to the CARI approach using food expenditure share categories

Appendix 3: Coefficients and marginal effects of ordered probit estimation

Variables ^a	Coefficients	Marginal Effects			
		Food Secure	Marginally food secure	Moderate food insecure	Severely food insecure
Major Explanatory Variable					
migration_remit_status (migrant-no-remittance)	0.473*** (0.182)	-0.101*** (0.0342)	-0.0111 (0.0193)	0.111** (0.0465)	0.0011 (0.0014)
migration_remit_status (migrant_remit-receiving)	0.834*** (0.144)	-0.150*** (0.0255)	-0.073*** (0.0257)	0.220*** (0.0402)	0.0035 (0.0032)
Control Variables					
gender_hh_dummy	0.0912 (0.147)	-0.0168 (0.0271)	-0.0069 (0.0110)	0.0230 (0.0370)	0.0006 (0.0012)
Age_HHH	0.00670 (0.00530)	-0.0012 (0.0010)	-0.0005 (0.0004)	0.0017 (0.0013)	0.0000 (0.0001)
Family_type_dummy	0.249 (0.154)	-0.0457 (0.0284)	-0.0187 (0.0120)	0.0627 (0.0382)	0.0017 (0.0017)
Total_school_yrs_HHH	-0.0514*** (0.0149)	0.009*** (0.0028)	0.004*** (0.0014)	-0.013*** (0.0036)	-0.0003 (0.0003)
Highest_edu_women_years	0.0387** (0.0163)	-0.0071** (0.0030)	-0.0029** (0.0013)	0.0098** (0.0039)	0.0003 (0.0002)
Dist_nearby_market	-0.0339** (0.0157)	0.0062** (0.0028)	0.0025* (0.0014)	-0.0085** (0.0039)	-0.0002 (0.0002)
Dist_near_motorable_road	-0.0206** (0.00961)	0.0038** (0.0018)	0.0016* (0.0008)	-0.0052** (0.0024)	-0.0001 (0.0001)
high_caste	-0.0841 (0.138)	0.0154 (0.0253)	0.0063 (0.0103)	-0.0212 (0.0345)	-0.0006 (0.0011)
HH_size	-0.0481** (0.0242)	0.0088** (0.0045)	0.0036* (0.0020)	-0.0121** (0.0061)	-0.0003 (0.0003)
eco_active_mem	-0.0865** (0.0401)	0.0159** (0.0073)	0.0065** (0.0033)	-0.0218** (0.0099)	-0.0006 (0.0005)
LSU	-0.0162 (0.0377)	0.0030 (0.0069)	0.0012 (0.0028)	-0.0041 (0.0095)	-0.0001 (0.0003)

Variables ^a	Coefficients	Marginal Effects			
		Food Secure	Marginally food secure	Moderate food insecure	Severely food insecure
land_size_Ha	0.223 (0.308)	-0.0410 (0.0565)	-0.0168 (0.0240)	0.0562 (0.0779)	0.0015 (0.0025)
access_agriland	-0.0253 (0.141)	0.0046 (0.0259)	0.0019 (0.0106)	-0.0064 (0.0356)	-0.0002 (0.0010)
food_stock_dummy	0.00485 (0.143)	-0.0009 (0.0263)	-0.0004 (0.0108)	0.0012 (0.0361)	0.0000 (0.0010)
agri_prod_mt	-0.0138 (0.0205)	0.0025 (0.0038)	0.0010 (0.0016)	-0.0034 (0.0052)	-0.0001 (0.0002)
access_credit_dummy	-0.117 (0.165)	(0.0495) 0.0254	(0.0088) 0.0127	(-0.0295) 0.0415	(-0.0008) 0.0015
Forein_aid_project_dummy	-0.270* (0.138)	0.0495 (0.0254)	0.0203 (0.0121)	-0.0680 (0.0354)	-0.0018 (0.0016)
μ_1	-1.462*** (0.318)				
μ_2	0.682** (0.299)				
μ_3	3.213*** (0.493)				

N=386; Wald chi2(19) = 98.65; Prob > chi2 = 0.0000; Log pseudolikelihood = -302.82077

Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

^aFor an explanation of the variable abbreviations, please refer to Table 3.

Appendix 4 Multinomial Selection results with Switching Ordered Probit Outcomes for selection correction terms

Covariates	Multinomial Selection		Selection Correction after regime specific ordered Probit		
	Regime 2 Vs Baseline	Regime 3 Vs Baseline	Regime 1	Regime 2	Regime 3
gender_hh_dummy	0.406 (0.369)	0.0654 (0.288)	-0.0359 (0.261)	0.116 (0.432)	0.207 (0.248)

Covariates	Multinomial Selection		Selection Correction after regime specific ordered Probit		
	Regime 2 Vs Baseline	Regime 3 Vs Baseline	Regime 1	Regime 2	Regime 3
Age_HHH	0.0188 (0.0140)	0.0156 (0.0115)	0.0150 (0.0118)	0.00792 (0.0157)	-0.00847 (0.0104)
Family_type_dummy	0.261 (0.355)	0.412 (0.292)	-0.331 (0.286)	0.414 (0.357)	0.198 (0.295)
Total_school_yrs_HHH	0.00732 (0.0372)	-0.0146 (0.0299)	0.00338 (0.0256)	-0.0524 (0.0427)	-0.0769*** (0.0260)
Highest_edu_women_years	0.141*** (0.0384)	0.133*** (0.0305)	-0.0618 (0.0577)	0.0983** (0.0402)	-0.0216 (0.0370)
Dist_nearby_market	0.0593* (0.0342)	0.0213 (0.0327)	-0.0473* (0.0282)	-0.00139 (0.0422)	-0.00418 (0.0327)
Dist_near_motorable_road	-0.0452 (0.0814)	0.00515 (0.0218)	-0.0389 (0.0742)	-0.114 (0.154)	0.0172 (0.0511)
high_caste	-0.314 (0.352)	-0.504* (0.291)	0.0516 (0.284)	-0.214 (0.353)	-0.0306 (0.258)
HH_size	-0.0259 (0.0716)	-0.102 (0.0674)	-0.00169 (0.0628)	-0.00909 (0.0732)	-0.0477 (0.0567)
eco_active_mem	0.0567 (0.100)	0.120 (0.0928)	-0.134 (0.0840)	-0.223** (0.0996)	-0.0425 (0.0829)
LSU	-0.167* (0.0964)	-0.132* (0.0685)	0.0553 (0.0416)	-0.100 (0.103)	-0.126* (0.0768)
land_size_Ha	0.386 (0.889)	0.849 (0.638)	-0.0228 (0.689)	2.047 (1.317)	-1.172** (0.594)
access_agriland	-0.240 (0.351)	-0.664** (0.291)	0.522 (0.330)	-0.147 (0.402)	0.109 (0.250)
food_stock_dummy	0.0637 (0.374)	-0.235 (0.300)	-0.0123 (0.269)	-0.568 (0.421)	0.379 (0.248)
agri_prod_mt	-0.0338 (0.0589)	-0.0328 (0.0413)	-0.00730 (0.0324)	-0.00770 (0.0674)	0.0837 (0.0537)
access_credit_dummy	0.0487 (0.394)	-0.595* (0.319)	-0.694** (0.307)	0.392 (0.409)	0.426 (0.273)
Forein_aid_project_dummy	-0.181 (0.334)	-0.273 (0.276)	0.176 (0.258)	-0.0800 (0.346)	-0.719*** (0.236)

Covariates	Multinomial Selection		Selection Correction after regime specific ordered Probit		
	Regime 2 Vs Baseline	Regime 3 Vs Baseline	Regime 1	Regime 2	Regime 3
mig_relativ_fri_num	-0.674*	1.048***			
	(0.357)	(0.308)			
/cut1			-0.748	0.0823	0.621**
			(0.695)	(1.937)	(0.296)
/cut2			1.905***	2.257	-3.976***
			(0.711)	(1.955)	(0.900)
lambda1			-0.674		
			(0.551)		
lambda2				-0.571	
				(0.392)	
lambda3					-1.778**
					(0.860)
Constant	-2.255**	-2.408***			
	(0.953)	(0.809)			
Observations	387	387	158	71	158

Note: Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Base Categories are Non-migrants (Regime 1), and Regime 2 & Regime 3 are migrant-non-remitting and migrant-remitting, respectively.

Appendix 5: IAA test after multinomial logit regression (Multinomial selection)

Test for IAA	Excluded Category	χ^2	df	p-value
Hausman	Non-migrant	4.686	19	1
	Migrant-non-remitting	-1.203	19	NA
	Migrant-remitting	-1.946	19	NA
SUEST-based Hausman	Non-migrant	21.383	19	0.316
	Migrant-non-remitting	9.517	19	0.964
	Migrant-remitting	8.45	19	0.982
Small-Hsiao	Non-migrant	36.616***	19	0.009
	Migrant-non-remitting	46.493***	19	<0.001
	Migrant-remitting	26.792	19	0.11

Note: *** p<0.01, ** p<0.05, * p<0.1