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Household food security: Trends and determinants in mountainous districts of Nepal

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Abstract

This paper assesses household food security and identifies the factors affecting it in two mountainous districts of Nepal using census data from 2011/12. A binary logit model has been used because the dependent variable is dichotomous. In the study districts, farmland expansion was the major contributor to the increased production of major crops over the period 1974/75 to 2013/14. The yield growth of major crops, with the exception of potato and wheat, remained below the population growth in these districts. On average, households experienced no food shortages for about 9 months out of the year; cultivated land per household was 0.63 ha, of which around 29% was irrigated; 22% of the households were female headed; and 60% of the households worked in allied activities alongside agriculture. The results show that household food security was positively affected by the following variables: male-headed household, household members with both agricultural and allied occupation, age of the household head, percentage of irrigated area, number of livestock owned by the household, and owner operator. Household food security was negatively affected by the variables household size and time taken to reach the nearest market. Taplejung district's food security was better than that of the Bajura district. The findings imply that female-headed households need support in order to improve their food security. There is a need for on-farm value-added processing and off-farm employment opportunities, which could be provisioned by financial support and development of the required technical and managerial skills. Public investment should be increased in markets, roads and irrigation infrastructure development in rural areas. Moreover, improving access to land and its utilization based on comparative advantage could improve household food security.

Introduction

Food security is an important issue for both the developed and developing countries. However, the situation in developing countries is more severe. Out of 795 million people suffering from hunger, 780 million live in developing countries (Food and Agriculture Organization (FAO), 2015). Compared to other regions, the progress towards reducing the number of hungry and malnourished people has been slow in South Asia and sub-Saharan Africa, despite many success stories at country and sub-regional levels. The highest burden of hunger occurs in South Asia, where as many as 281 million people are undernourished (FAO, 2015).

Land is an important factor for food production. Among the South Asian countries, the ratio of agricultural land to total land is lowest in Bhutan (13.8%), whereas this ratio is highest in Bangladesh (69.9%). The ratio for Nepal is 28.7% (World Bank, 2017). Food availability in Nepal is aggravated by a myriad of complex issues, including, but not limited to, waning agricultural production rates, rising population pressure, declining soil quality, and the mountainous terrain. The increasing demand for food

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has to be fulfilled from the same amount of agricultural land, yet a growing number of studies from Nepal suggest that, in some areas, more than 30% of total cultivated land has been abandoned (Khanal & Watanabe, 2006).

Hunger and malnutrition are pervasive across Nepal and affect certain groups of people and households more than others. Within a physiographic region, some communities are more food insecure because of their social and/or economic status. Households are said to be food secure if their entitlements or demand for food is greater than or equal to their household needs (Pant, 2012). Sen developed the entitlement theory in order to provide a more convincing answer to household level food insecurity. Entitlements are the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces (Sen, 1981). The production-based entitlements among households are affected by land endowments. Moreover, the people residing in remote areas, such as mountains and hills, and those without gainful employment suffer more from household-level food insecurity. Risk of food insecurity is also increased for those who rely on subsistence agriculture with limited off-farm income and those who depend on the market for food due to market imperfections and escalated prices for consumers (Pant, 2012).

Much of the food security-related literature on Nepal is based on qualitative and descriptive analysis and is mostly concentrated at the national and regional level. This shows the necessity of a study regarding food security at the household level based on empirical analysis. Understanding the issue from a micro perspective would be important in dealing more effectively with the problem of food security and consumption. Therefore, this paper aims to analyze the production and productivity of major crops, assess the edible food grain production and requirements, and identify the factors affecting household food security in two mountainous districts of Nepal.

Literature Review

Food security as a concept originated only in the mid-1970s during discussions about international food problems at a time of global food crisis. Since its introduction, the academic community and political sphere has evolved, developed, and diversified this concept (Giraldo, Betancur, & Arango, 2008). The International Fund for Agricultural Development (IFAD, 1999) defines Household Food Security as "the capacity of households to procure a stable and sustainable basket of adequate food". A comprehensive definition was given by the Rome Declaration on World Food Security (FAO, 1996): "Food security exists when all people at all times have physical and economic access to sufficient, safe, and nutritious food, which meets their dietary needs and food preferences for an active and healthy life."

The Rome Declaration also pledged political will and a common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate goal of reducing the number of both impoverished people and undernourished people to half their 1990 level by no later than 2015. In this regard, Nepal met the target of halving absolute poverty and will soon halve the proportion of people who suffer from hunger. The Millennium Development Goal (MDG) target of reducing the prevalence of underweight children aged 6-59 months was achieved. For example, the proportion of stunted children decreased to 37.4% by 2014, surpassing the target of a 30% decrease (National Planning Commission (NPC), 2015).

Access to an adequate supply of food is the most basic human need and right. There are four main dimensions of food security: food availability, access, utilization, and stability (FAO, 2008). Food availability at the national level, food access to households, and its utilization by individuals are the core aspects of food security. In general, the determinants of food security are different at different levels of application, i.e., global, national, regional, household and individual levels (Khan, Azid & Toseef, 2012).

Several studies have been carried out to identify the determinants of food security in various contexts and levels using different variables and methodologies. Some studies have focused on household characteristics, such as size and structure; gender, educational attainment and age of the household head; or household preferences and tastes as the main drivers of food insecurity (Kidane, Alemu, & Kundlhande, 2005; Kabbani & Wehelie, 2005; Iram & Butt, 2004), while others looked at economic factors, such as income and consumption patterns, or food and input prices (Makombe, Lewin, & Fisher, 2010; Onianwa & Wheellock, 2006). Other studies have found issues of land size and productivity, fertilizer application, ownership of cattle and production of grains to be key (Khan & Gill, 2009; Kidane, Alemu, & Kundlhande, 2005). Additionally, access to markets, land, and water; production and marketing infrastructure, and also availability of services such as extension were variables identified as vital to food security (Misselhorn, 2004; Makombe, Lewin, & Fisher, 2010).

Tefera and Tefera (2014), using a logistic regression model in Ethiopia, found that the age of household head, level of education, household size, size of cultivated land,

use of improved seed, number of contacts with development agents, size of credit received, size of livestock owned, and off-farm income all significantly affected food security. Similarly, using logistic regression in Nepal, Maharjan and Joshi (2011) revealed that any program targeting occupational castes, small landholders or the landless and the provision of employment opportunities for the economically active age group would contribute significantly to reduce food insecurity. In this case the probability of being food insecure rose with an increase in family size, while an increase in irrigation availability contributed significantly to reducing food insecurity. Additionally, a significant proportion of male-headed households and households residing in Terai were found to be food secure.

Bashir, Schilizzi, and Pandit (2013) examined the regional sensitivity of rural household food security in three regions of Pakistan using logistic regression. The results revealed that livestock assets had a positive impact on food security across all three regions, while family size had a negative impact. Intermediate and graduation levels of education improved food security in Northern and Central regions, respectively. In the Northern region, total number of income earners in the household also positively impacted food security, while age of the head of household had an inverse relationship with food security. The results imply that targeted, region-specific policies are needed to improve food security in Punjab.
A logistic regression analysis in Bangladesh by Ali, Noor, and Alam (2016) revealed that, for the head of household, age, income, and the level of education positively and significantly influenced household food security, while the number of dependents (i.e., household size) influenced food security negatively.

The impact of climate change on food security differs by gender and economic class. The dependence of women on subsistence farming is relatively high in Nepal. With increasing migration of young men away from rural areas of Nepal, the farming system is highly feminized; the agricultural labor inputs of women are very high. Therefore, rising temperatures, unpredictable precipitation patterns, and an increase in extreme-weather events will have a disproportionate impact on women who depend on subsistence farming for their livelihoods (Adhikari, 2014). Pokhrel and Pandey (2011) mentioned that in Nepal, decreasing availability of food is likely due to climate-induced reduction in crop productivity, decreasing availability of agricultural water or inefficiency of conventional irrigation systems, poor availability of quality inputs/breeds, under-utilization of available technologies, the cereal-based food habit, agricultural land depletion and degradation and, on account of these factors, possible occupational shifts, migration and resultant land fallowing.

In Nepal, the abandonment of farmland is due to low returns, which encourages people to migrate to non-farm jobs, especially to foreign labor markets, causing further shortages of labor and high wages (Adhikari & Hobley, 2012). Every day, about 1,500 to 1,700 Nepali youths, mainly male, migrate to the Gulf States, Malaysia and India for work (Adhikari, 2014).

As per the Ministry of Agricultural Development (MOAD, 2012), households in the Far Western Hill area experience food consumption gaps and high or above-average acute malnutrition, or meet minimal food needs only with accelerated depletion of livelihood assets. For these reasons, this area is categorized as chronically food insecure (Integrated Food Security Phase Classification - IPC Level III). On average, the annual food production in the area covers the needs for only nine months of each year, the production of wheat and maize has been decreasing over the past five years, the performance of nutrition and health-related indicators are extremely low, and the region is classified as being highly vulnerable to natural disasters, including drought, floods and landslides. On the other hand, households in the Eastern Mountain area meet their minimal food needs with traditional coping strategies, but are unable to afford some essential non-food expenditures without engaging in irreversible coping strategies. Hence, they fall under chronic food insecurity at IPC Level II. The indicator data for food access, nutrition, vulnerability and utilization shows some sign of food insecurity, although there is no substantial problem of food availability and stability.

The average landholding size in Nepal declined from 1.13 ha in 1981 to 0.80 ha in 2001 and 0.68 ha in 2011 as per Central Bureau of Statistics (CBS, 2003; CBS, 2014). The size of landholding and food self-sufficiency has a positive correlation. Only about 6% of the households with less than 0.1 ha are food self-sufficient from their own production, while 63% with holdings above 0.5 hectare are self-sufficient (CBS, 2013). As of 2015, Nepal ranked 58th among 104 countries in terms of the Global Hunger Index (GHI). The score improved from 44.5 in 1990 to 31.6 in 2005, and to 22.2 in 2015 (von Grebmer, 2015).

Materials and Methods

Description of the Study Districts

Bajura is a mountain district in the far-western development region, covering an area of 2,188 km^2. Martadi, the district headquarters, lies at a distance of 950 kilometers from Kathmandu. The elevation of the district varies from 300 m to 6,400 m above sea level (masl), which

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Figure 1: The Study Districts in Nepal, Source: Author

divides the district into three distinct regions from north to south: higher Himalayan, higher mountains and mid mountains. This results in a variation in temperature, which ranges from 0°C during winter to 40°C during summer. The annual average rainfall is 1,343 mm, which decreased at a rate of 18.25 mm/year over the period 1976-2011. In addition, the inter-annual variation of rainfall is pronounced over the same period. The combined climate change vulnerability index for Bajura is moderate; however, it is highly vulnerable for drought and moderately vulnerable for landslide. In addition, ecologically, this district is highly sensitive to climate change (Sherpa et al., 2015). The average population density is around 62 people per square km, with a family size of 5.4. The average land holding is 0.42 ha and almost 76% of the agricultural land is non-irrigated (CBS, 2013). The map of Nepal showing the study districts is presented in **Figure 1**.

Taplejung is a mountain district in the eastern development region, covering an area of 3,646 km^2. Phungling, its district headquarters, lies at a distance of 674 kilometers from Kathmandu. The elevation ranges from 777 to 8,598 masl. The average annual temperature is 11.3°C (0°C during winter and 30°C during summer). The annual average rainfall is 1,440 mm, which decreased at a rate of 5.6 mm/year over the period 1975-2009. This district is vulnerable to rainfall and temperature-related extreme events. The average annual maximum and minimum temperature have increased over the period from 1981 to 2010. The combined vulnerability index is moderate, which may be linked with low socio-economic status as well as inadequate roads and market infrastructure (Sherpa et al., 2015). The average population density is around 35 people per square km, with a family size of 4.8. The average land holding is 0.95 ha and about 73% of the agricultural land is non-irrigated (CBS, 2013).

Data Sources

The latest agricultural census data (2011/12) collected by the Central Bureau of Statistics (CBS) was used for this study. Two districts from mountainous regions, one each from the eastern (Taplejung) and far western (Bajura) regions, were purposely selected. The basic sampling methodology was a two-stage area sampling, as follows: in the first stage, selection was based on a stratified sample of enumeration areas (EAs) with probability proportional to the expected number of agricultural holdings (stratified PPS sampling); in the second stage, within selected EAs, a selection was made of a sample agricultural holding using stratified systematic random sampling. The EAs were defined as wards (the smallest administrative and political units). They contained less than 25 holdings or possibly more than 25 but less than or equal to 30 holdings if wards were combined. As a result, between 20 and 30 holdings were selected in each selected EA (CBS, 2013). For this study, 18 EAs from Taplejung with a total of 430 holdings, and 19 EAs from Bajura with a total of 451 holdings were selected, with a total sample size of 881 holdings.

Analytical Framework

Food security is multidimensional and involves complex realities, processes, and linkages. The Food Insecurity and

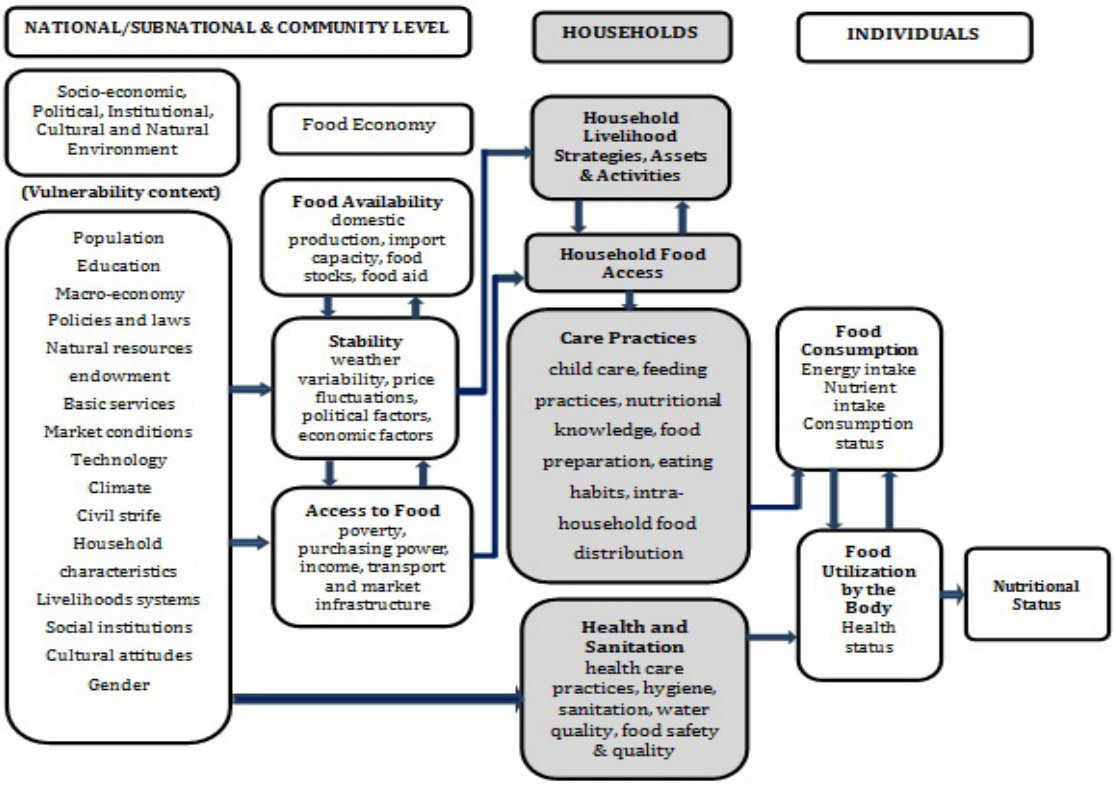

Figure 2: FIVIMS nutrition framework: linkages between the overall development context, the food economy, households and individual measures of wellbeing, Source: FAO, 2008

Vulnerability Information and Mapping System (FIVIMS) framework developed by FAO (2008) has been used in order to understand linkages among various food security dimensions and to explain linkages with underlying causes and outcomes (**Figure 2**). This framework highlights the need to consider underlying socio-economic, political, institutional, cultural and natural factors, as they impact different dimensions of food security (i.e., food availability, access, stability, and utilization), while also affecting care practices, in addition to conditions related to health and sanitation. These dimensions interact in a sequential manner, i.e., food must be available, then households must have access to it, then they must utilize it appropriately, and then the whole system must be stable (Barrett, 2010).

Food availability is determined by the level of domestic production, the capacity to import and receive food, the ability to maintain stocks and reserves, and the functioning of markets. Food consumption at the household level is affected by access to food and child care. Food access is determined by relative poverty/incomes, purchasing power, income transfers, quality of transport, and market infrastructure. Factors such as intra-household food allocation, cultural practices, and knowledge related to food preparation affect the level of child care. Efficient and effective food utilization by the human body is understood to be primarily dependent on a person's health status, which in turn is dependent on general health and sanitation. The nutritional outcome is understood to be dependent on food consumption (food intake in terms of energy and nutrients) and the biological utilization of this food (determined by a person's health status). If the dimensions of availability, access and utilization are sufficiently met such that households have adequate quality and quantity of food, the next question is whether or not the whole system is stable, thus ensuring that households are food-secure at all times. Climatic, economic, social and political factors can all be sources of instability.

Analytical Method

Many socio-economic and demographic features of farm households affect food security and food availability. Binary logit or probit models are employed when the number of choices available is limited to two. In this study, a binary logistic regression model has been used to examine the factors influencing household-level food security. The distribution functions are bounded between 0 and 1. The model is based on the cumulative logistic probability function. It uses logistic CDF and is specified as (Pyndick & Rubinfeld, 1991):

$$P_{1/i} = F(\alpha + \beta Xi)\frac{1}{1+e^{-(\alpha+\beta Xi)}} = \frac{e^{(\alpha+\beta Xi)}}{1+e^{(\alpha+\beta Xi)}} \quad (1)$$

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Table 1: Average calorie consumption in Nepal, Source: NPC (2013)

Population	Average kilocalories consumed per capita per day	Percent of the population with food energy deficient
Nepal	**2,536**	**38**
Urban	2,525	43
Rural	2,539	37
Regions		
Mountains	2,403	45
Urban - Kathmandu	2,481	53
Urban - Hill	2,524	42
Rural Hills - Eastern	2,542	43
Rural Hills - Central	2,422	45
Rural Hills - Western	2,452	42
Rural Hills – Mid and Far Western	2,331	49
Rural Terai – Eastern	2,640	28
Rural Terai – Central	2,762	23
Rural Terai – Western	2,590	34
Rural Terai – Mid and Far Western	2,515	37

Where F = cumulative logistic probability function, e = base of natural logarithm, and $P_{1/i}$ = probability that the individual makes a certain choice. Futhermore,

$$P_{1/i}(1+ e^{\alpha + \beta X i}) = e^{\alpha + \beta X i}$$

$$P_{1/i} = (1- P_{1/i}) * e^{\alpha + \beta X i}$$

$$P_{1/i} / (1- P_{1/i}) = e^{\alpha + \beta X i}$$

$$\log_e(P_{1/i} / P_{2/i}) = P_{1/i} / (1- P_{1/i}) = \alpha + \beta X_i = Z_i \quad (2)$$

The left-hand side of equation (2) is known as the log odds or the logit transformation and the model is known as the linear logit model. Wigly (1985) pinpointed the importance of logit transformation: it increases from - ∞to + ∞ as $P_{1/i}$ increases from 0 to 1. Thus, while the probability is bounded, the logit is unbounded with respect to the values of X. According to Wigly, the predicted Logit values

$$\hat{L}_{1;2/i} = \log e \left\{ \frac{\hat{P}_{1/i}}{\hat{P}_{2/i}} \right\} = \hat{\alpha} + \hat{\beta} X_i \quad (3)$$

are likewise unbounded, but the predicted probability (which can be found by substituting $\hat{\alpha}$ and $\hat{\beta}$ into equation (3) are confined to a range of 0-1. In this study, $P_{1/i}$ represents the probability that individual household 'i' is self-sufficient for 12 months and 1- $P_{1/i}$ = $P_{2/i}$ = 1/ (1+ e $^{(\infty + \infty X i)}$) represents the probability that individual household 'i' is not. The logistic regression model has been used by Maharjan and Joshi (2011) to identify the determinants of food security and by Joshi, Maharjan and Piya (2012) for identifying variables with a significant impact on income and poverty in Nepal.

The estimation of marginal effects are likewise important. Marginal effects refer to the partial derivatives of the expected value with respect to the vector of characteristics. They are computed at the means of the Xs. Marginal effects show the change in probability when the predictor or independent variable increases by one unit. Since

$$P_{1/i} = \frac{1}{1+ e^{-(\alpha + \beta X i)}}$$

as per equation (1), taking a partial derivative of the above equation with respect to X_i, the following formula is derived to estimate the marginal effect of X_i:

Table 2: Annual growth rate of population and cereals production in Nepal (%) , Source: MOAD (2013b)

Period	Cereals	Population
1981-90	5.3	2.1
1991-2000	2.3	2.3
2001-2011	1.7	1.4

Table 3: Annual compound growth in area, production and yield (%)
Source: Compiled and calculated by the author from MOAD (2014), MOAD (2013a), Ministry of Agriculture and Cooperatives (MOAC, 2005), Department of Food and Agricultural Marketing Services (DFAMS, 1990), and DFAMS (1977)

Crops/Period	Taplejung			Bajura		
	A	P	Y	A	P	Y
Paddy	5.25	5.19	-0.06	0.96	1.02	0.06
Maize	3.09	3.81	0.72	0.27	1.03	0.76
Wheat	4.05	5.84	1.79	3.44	5.10	1.66
Millet	2.76	2.46	-0.30	3.08	2.90	-0.18
Potato	3.47	6.40	2.93	4.59	6.84	2.25

$$\delta P(1/i) / \delta Xi = P1/i \times (1\text{-}P1/i) \times \beta_i \quad (4)$$

Results and Discussion

The status of agricultural growth, nutrition and consumption, cereal production, and population growth at the national and sub-national level, as well as production and productivity of major crops and socio-economic characteristics of the districts under study are presented in the following sections.

Agricultural Growth

Agriculture provides a livelihood to two-thirds of the population and contributes about one-third of the GDP in Nepal (Ministry of Finance (MOF), 2015). The structure of the economy in Nepal has changed slightly over the years. The contribution of agriculture to GDP fell by 10% over a period of about 20 years (44% in 1990-92 to 34% in 2012-13). The average rate of real Agricultural Gross Domestic Product (AGDP) growth per annum during 1974 to 1998 remained at 1.77%, while it was 3.62% during 1999 to 2014. It is also evident that this growth is fluctuating: ranging from 4.2% in 2000/01 (MOF, 2002), to 1% in 2006/07, to 5% in 2011/12 (MOF, 2013), to 0.8% in 2014/15 (MOF, 2016).

Status of Nutrition and Calorie Intake

Nepal's population confronts various forms of nutritional problems, ranging from deficits in energy intake to imbalances in consumption of specific macro and micronutrients. Nepal has a problem of chronic under-nutrition, leading to the stunting of children (NPC, 2012). The cost of mineral and micronutrient deficiencies alone in Nepal is estimated at 2-3% of GDP, equivalent to US$250-375 million annually (NPC, 2012).

The national average dietary energy intake was 2,536 Kcal per capita per day; a level that is higher than the minimum average adequate requirement of 2,220 Kcal set by the Government of Nepal (NPC, 2012). However, poor diet diversity is a serious problem across much of the country. While the average Nepalese consumes sufficient calories, staple food items constitute 72% of the average household diet, which is considered very high (NPC, 2013).

Food energy intake varies significantly between Nepal's geographic regions (**Table 1**). The highest per capita intake of calories was in Rural Terai-Central (2,762 Kcal

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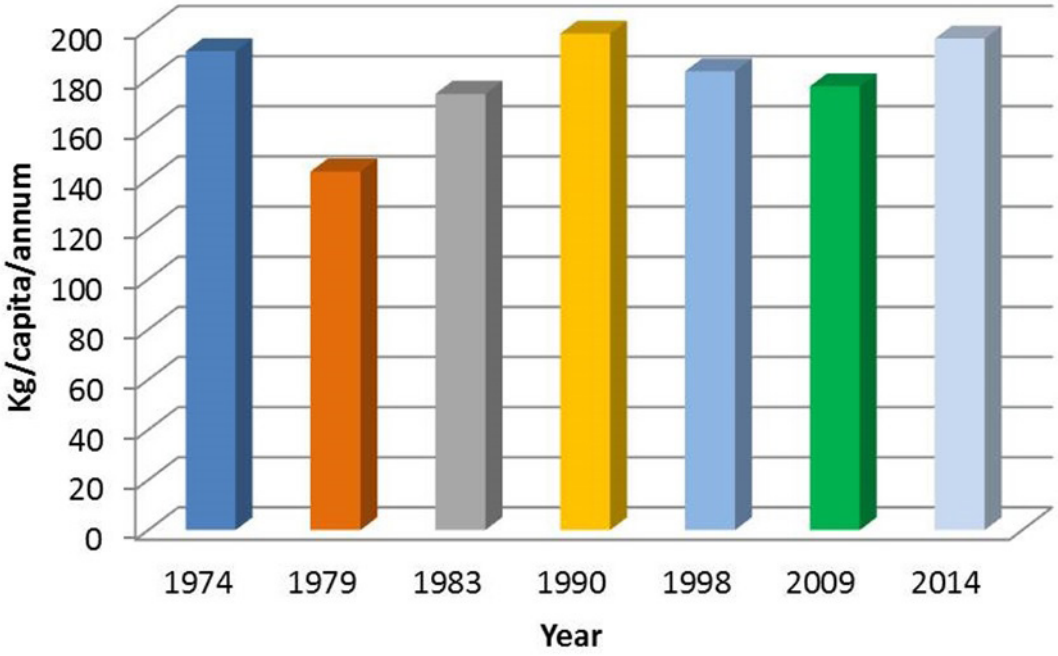

Figure 3: Changes in per capita edible food grain availability in Nepal
Source: Compiled and calculated by the author from MOAD (2015), MOAD (2010), MOAC (2005), DOA (2015), DFAMS (1977), DFAMS (1990)

per day), compared to the lowest per capita intake in Rural Hills-Mid and Far Western (2,331 Kcal per day). In the mountains of Nepal, the average per capita intake was below the national average, with 45% of the population consuming less than the national minimum calorie threshold.

Growth in Cereal Production and Population

Nepal was self-sufficient in food production up until 1990, when population growth surpassed food production growth. During the following decade, substantial efforts were made to restore national food self-sufficiency, which was achieved again in 1999. But this pressure reduced the resilience of Nepal's agriculture and, following adverse weather conditions and natural disasters, national food production has remained insufficient to meet the needs of the population since 2005. Population and cereal production since 1985 have both more than doubled, and are set to double again by 2040 (MOAD, 2013b). The annual population growth rate is falling slowly, and over the last decade, the population growth rate appears to have been lower than the cereal growth rate (**Table 2**).

Production of Major Food Crops

Rice, maize, wheat and potato are the major food crops in Nepal. These crops account for nearly 71% of the total cropped area and nearly 73% of the production of food crops, including vegetables (MOAD, 2015). The growth in area, production and yield of these crops in the Bajura and Taplejung districts from 1974-2013 are presented in **Table 3**. The growth in production is the sum of growth in area and yield. It shows that area expansion was the major contributor to the increased production of paddy and millet. The contribution of yield growth to total production growth remained at 33-45% in the case of potato, 19-74% for maize and 31-33% for wheat. The yield growth of major crops except potato and wheat remained below the population growth in these districts.

For estimating edible food production and requirement, five major food grains (paddy, wheat, maize, millet and barley) were considered. The per capita per annum edible food grain availability at the national level has fluctuated over time (**Figure 3**). It was 191 kg during 1974/75 (DFAMS, 1977), but decreased to 177 kg in 2009/10 (MOAD, 2010). Subsequently, it increased again to reach a level of 196 kg in 2014/15 (MOAD, 2015; Department of Agriculture (DOA), 2015). The increasing food supply imbalance is mainly due to slow growth in agricultural productivity, limited arable land for bringing additional area under cultivation, and an unfavorable trade balance for the import of food (FAO, 2010). Part of the deficit is met by foods such as potatoes, meat, fish, and eggs. Out of 75 districts, 46 were found to be food deficient during 2006/07, but the number declined to 32 in 2014/15 (DOA, 2015). Although the number of food deficient districts at an aggregate level is decreasing, the mountain districts are particularly vulnerable to food insecurity. Low production and productivity is largely due to the predominance of rain-fed agriculture, traditional farming practices, ineffective agricultural service delivery

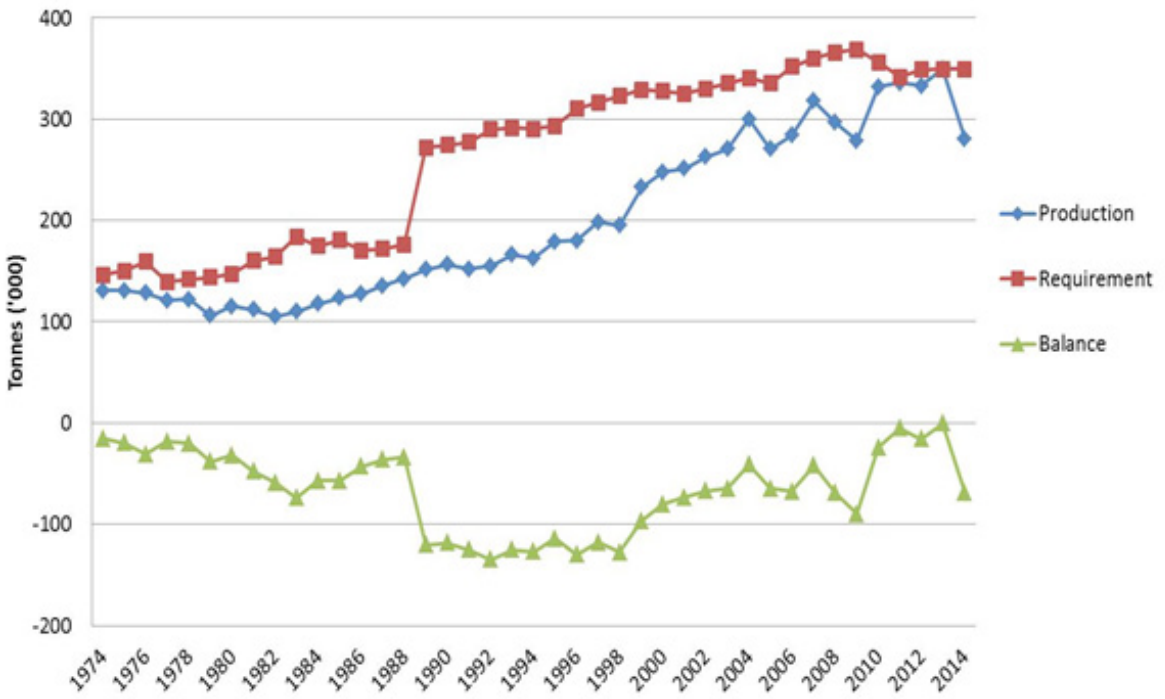

Figure 4: Production and requirement of foodgrains (in edible form) in mountains of Nepal
Source: Compiled and calculated by the author from MOAD (2015), MOAD (2013a), MOAC (2005), DOA (2012), DOA (1997), DFAMS (1990), and Joshi and Khatiwada (1986)

Table 4: Socio-demographic characteristics of the households, Source: Calculated by the author from CBS (2013)

Districts	Family size (No. of individuals)	Age of the House-hold Head (Years)	Female Headed Household (%)	Education of House-hold Head (No. of years of schooling)
Taplejung	4.75	47.1	24.4	3.1
Bajura	5.96	43.3	15.2	2.6
Average	5.37	45.2	21.5	2.8

Table 5: Holding size, food self-sufficiency and related information, Source: Calculated by the author from CBS (2013)

Districts	Holding size (ha)	Area irrigat-ed (%)	Average Food insufficiency (months)	Households with agriculture and allied activities (%)	No. of live-stock
Taplejung	0.99	32.9	2.7	96.5	7.40
Bajura	0.29	24.9	3.6	20.0	8.69
Average	0.63	29.1	3.1	60.0	8.00

and frequent droughts and floods (FAO, 2010).

The food production and balance scenario in the mountainous region of Nepal (which covers 16 districts) shows that the production quantity (in edible form) was below the requirement of the population in the period 1974-

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Table 6: Factors affecting household food security in mountain districts of Nepal

Variable	Marginal effects
Constant	-0.567
AGE HHHEAD	0.0025**
FAMILY SIZE	-0.0022**
PERCENT IRRIGATED	0.222***
MARKET DISTANCE	-0.023**
NO. OF LIVESTOCK	0.009***
HHHEAD DUMMY	0.102**
AG OTHER SOURCES DUMMY	0.168***
DISTRICT DUMMY	0.093*
OWN LAND DUMMY	0.026*
Likelihood Ratio (Chi-square)	104.74***
Pseudo R-square	0.10

***, ** and * indicate significance at a 1%, 5% and 10% probability level, respectively.

2014. It has also been fluctuating from year to year (**Figure 4**). In Nepal, almost all the mountain districts and some hilly districts have remained continuously food deficient over the last three or four decades.

Socio-economic Characteristics

The demographic and socio-economic characteristics of EAs of the two study districts are presented in Table 4. On average, the family size was 5 persons, the age of the household head was 45 years, the education level of the household head was just 3 years of schooling, and 21.5% of households were headed by a female. The dependency ratio, which is defined as the ratio of the dependent population (less than 15 years old and more than 60 years old) to the working age population was 0.78. This means that for every 100 working persons, there are 78 dependents).

The results showed that on average, the cultivated land per household was 0.63 ha, around 29% of the cultivated land was irrigated, and the households experienced food shortages for about 3 months of the year. Moreover, 60% of the households engaged in non-farm activities as well as working in agriculture (**Table 5**). However, the table also indicates the considerable difference in landholding size and percentage of households engaged in both agriculture and allied activities between the two districts: the figures for Bajura are very low compared with Taplejung.

Results of the Logit Model

The results of the logit model show that all the included variables were significant in influencing household food security (**Table 6**). The age of the household head, proportion of male-headed households, household size, and distance to market were significant at a 5 percent probability level. Among these variables, the household size and distance to markets negatively influenced food security, while the other two variables have a positive influence. The percent area irrigated, household members with both agriculture and allied occupation, and number of livestock were significant at a 1% probability level, while the district dummy and land ownership dummy were significant at a 10% probability level. The likelihood ratio was found to be highly significant, which implies that the level of food security is explained by the significant explanatory variables.

Male-headed households (HHHEAD DUMMY) were about 10% more likely to be food secure than female-headed

households. With one unit increase in the irrigated area (PERCENT IRRIGATED), the probability of food security increased by 22%. The significant positive relationship of household members with both agricultural and other income sources (AG OTHER SOURCES DUMMY) with food security implies that the diversification of employment opportunities among household members reduced the risk to income generation and hence contributes to food security. This may be due to the fact that households engaged in non-farm activities were better endowed with additional income and more likely to escape food insecurity. Similarly, the smallholders who solely depended on farm activities could have had inadequate income to purchase farm inputs and fulfill family needs and thus, they were found to be more food insecure. The households who had other allied occupations in addition to agriculture had an increased probability of being food secure of about 17%.

In general, households who earn their livelihoods from limited resources, such as land, may face food insecurity with increased family size (FAMILY SIZE). Indeed, bigger households were more likely to be food insecure than smaller ones: each additional household member increased the probability of a household being food insecure by 2.2%. The distance to market variable (MARKET DISTANCE) appeared to be negative and significant at a 5% level, which was unexpected. This could be because the roads and market facilities for buying and selling goods were not well-developed in the mountain districts. Most of the households walked to reach the nearest markets, which took four hours on average.

The age of the household head (AGE HHHEAD) variable shows that with a one year increase in the age of the household head, the probability of food security increased by 0.26%. With increased age, the household head gains experience in managing food insecurity by developing relevant coping strategies. The positive and significant dummy variable for ownership of the land (OWN LAND DUMMY) shows that the probability of food security was 7% higher for owner operators than for tenants. The district dummy (DISTRICT DUMMY: 1 for Taplejung, zero otherwise) variable was positive and significant, which implies that Taplejung (eastern mountains) was more food secure than Bajura (far-western mountains). The probability of being food secure was 9% higher for Taplejung than for Bajura.

The number of livestock (NO. OF LIVESTOCK) owned by a household had a significant positive influence on household food security. Livestock have many socio-economic benefits to farm households and are perceived as indicators of wealth; therefore, the possession of greater numbers of livestock implies a higher likelihood of food security. Possession of livestock mitigates the vulnerability of households during crop failures and other calamities. With one unit increase in livestock number, the probability of a household being food secure increased by 0.90%.

Conclusion

This study was carried out to review and assess the relationship between agricultural production and household food security, as well as identify major factors that influence food security. The study results show that female-headed households are more food insecure compared to male-headed households, while age of the household head is positively related to household food security. Similarly, households with a larger percentage of cultivated area with irrigation, members having off-farm occupation, a higher number of livestock, and status as the owner operator all contributed positively to food security. Bigger family size and greater distance to the nearest markets contributed negatively to household food security. The food security was higher in the eastern mountain districts compared to the far-western mountain districts. The findings imply that monetary and non-monetary support are needed by female-headed households to improve their food security. In addition, a financial, technological and skill-enhancing package should be provided to economically active household members to facilitate participation in on-farm value-added processing and off-farm activities. Investment should be increased in public goods, such as markets and road infrastructure in rural areas in order to improve physical access. Similarly, additional irrigation facilities need to be developed to augment the quality of land. Moreover, improving access to land and its utilization based on comparative advantage could improve household food security in the rural areas of Nepal.

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Conflict of Interests

The authors hereby declare that there is no conflict of interests.

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