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Determinants of food security among rural households in Majang Zone, Gambella Region, South-western Ethiopia

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Abstract

Attaining food security is a basic human right and a priority development agenda, although the challenge remains tough in the least developed countries. This study was conducted to evaluate the food security status of households and the factors influencing it in the Majang Zone. A multistage sampling method was utilized to select 320 households. The research adopted a mixed-methods approach, incorporating questionnaires, focus group discussions (FGDs), and key informant interviews (KIIs) to collect data. The analysis of the data was performed using descriptive statistics and binary logistic regression. The findings revealed that approximately 53% of the respondents were classified as food secure, while 47% were deemed food insecure. Significant positive determinants of household food security included beehives ($p<0.05$), formal education ($p<0.01$), landholding ($p<0.01$), oxen ploughing ($p<0.05$), livestock ownership ($p<0.05$), farm income ($p<0.01$), extension support ($p<0.01$), and family size ($p<0.10$). Conversely, age ($p<0.05$) and pesticide use ($p<0.05$) exhibited negative correlations. An increase of one unit in these factors would result in an enhancement of food security by 0.1014, 2.138, 1.489, 2.237, 0.9674, 0.0001, 2.469, and 0.7226 units, respectively. Similarly, a unit increase in the age of households and pesticide use tend to reduce food security status by 0.1091 and 2.071 units, respectively. The limitations of improved agricultural technologies such as improved inputs for crop and livestock; small irrigation schemes; institutions including credit services and cooperatives; and infrastructural developments, namely roads, niche markets, and rural electrification, coupled with undiversified income sources, call for holistic and sustainable strategic intervention from concerned bodies of the government and stakeholders at all levels to curb food insecurity challenges.

Keywords/Phrases: Food Consumption Score, Food security, Households, Logit, Majang

1 Introduction

Although it is still difficult, especially in low-income nations, ensuring food and nutritional security is a human and constitutional right of all residents. Food safety is maintained when "all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Clay, 2002, p. 2). Over 250 million individuals in Africa are among the nearly 690 million people who have experienced hunger worldwide despite attempts to address food security challenges (FAO *et al*., 2021). By 2020, the COVID-19 pandemic may have impacted 83–132 million individuals globally. This is an added challenge to 25 million estimated people living at or below the threshold of survival, Ethiopia continues to have a very high rate of poverty and food insecurity (Diriba, 2020). According to estimates from FAO *et al*. (2021) and IPC (2020), 8.5 million of them experienced acute food insecurity in the beginning of 2020. Approximately 10.2 million individuals faced emergency food security situations, as reported by Luminița

(2016). Debebe (2018) indicates that around 52% of the rural population and 36% of the urban population consume less than the minimum recommended intake of 2100 kcal per person per day. Over eight million individuals benefit from PSNP transfers due to the government's inclination to widen the food gap through food assistance (Gilligan *et al*., 2023).

Food insecurity and unsustainable food systems in Ethiopia are primarily caused by natural, social, physical, economic, and political reasons (Endalew *et al*., 2015; World Bank, 2010; Regassa, 2011; FAO, 2010; Andersson *et al*., 2011; Eneyew and Bekele, 2012). Another issue, according to Keller (2009), is gaps in program and policy implementation. According to Simane *et al*. (2016), drought, flooding, ecosystems, and biodiversity degradation are among the main reasons. The primary causes of food insecurity in Ethiopia, according to the FAO (2017), were famine and unpredictable rainfall or seasonal differences. Throughout the nation's history, frequent floods and droughts—like the most recent El Niño devastation in 2015 and 2016—have resulted in significant losses of life and property (FAO *et al*., 2017; UNDP *et al*., 2010; World Bank, 2017). Over the past fifty years, there have been more than fifteen drought occurrences in Ethiopia (Kasie, 2017). Additionally, it has been asserted that the nation is structurally food insecure, with food availability being hindered by political, economic, and infrastructural unrest, even though food may eventually become available (Vedeld *et al*., 2007).

Food insecurity in the research area has been linked to several factors, such as the improper use of natural resources, drought conditions, inadequate off-farm employment opportunities, health issues, limited access to markets and credit, insufficient access to drinking water and sanitation, gaps in policy, and the rising prices of food products (Mathewos & Bewuketu, 2018; Guyalo *et al*., 2022; Girma & Muluneh, 2021). Few studies have been done to address the fundamental problems that lead to food insecurity, notwithstanding the difficulties in guaranteeing food security. Regular government documentation and emergency assessment reports provide the majority of the information currently accessible on food security. This mismatch has led to inconsistent planning and execution of food security measures, redundant efforts, and improper prioritization. Additionally, a large number of households in the region rely on the forest and non-timber items associated to it for their livelihoods; nevertheless, scientific studies rarely address these issues. In order to solve these problems, the Majang zone's rural households' food security status was examined in relation to food security determinants.

2 Materials and Methods

2.1 Description of the Study Area

The Majang zone in the Gambella Region of Ethiopia was the site of this investigation. The zone is situated between latitudes 7°4'2.41" N and 7°46'47.79" N and longitudes 34°36'30.54" E and 35°38'48.00" E. The entire research area is made up of the Zone's two districts, Godere and Mangeshi (Figure 1). The study location experienced hot and humid weather. The mean annual rainfall was calculated to be around 2100 mm, despite the lack of meteorological stations. The range of the mean temperature was 20 to 33°C. According to Guyalo *et al*. (2022), the region is distinguished by a flat to gently sloping terrain with deep, rocky valleys around major streams and hills. The population of the zone reaches 89,033, with 46,119 men and 42,914 women, according to the CSA's predicted population census for 2022. Its estimated population density was 39.5 persons per square kilometer. The two districts, Godere and Mangeshi, have projected populations of 61,079 and 27,954, respectively, with an average family size of 5.3 individuals. Additionally, a significant proportion of the population is under the age of 20, exceeding 60%. Approximately 88% of the inhabitants reside in rural regions.

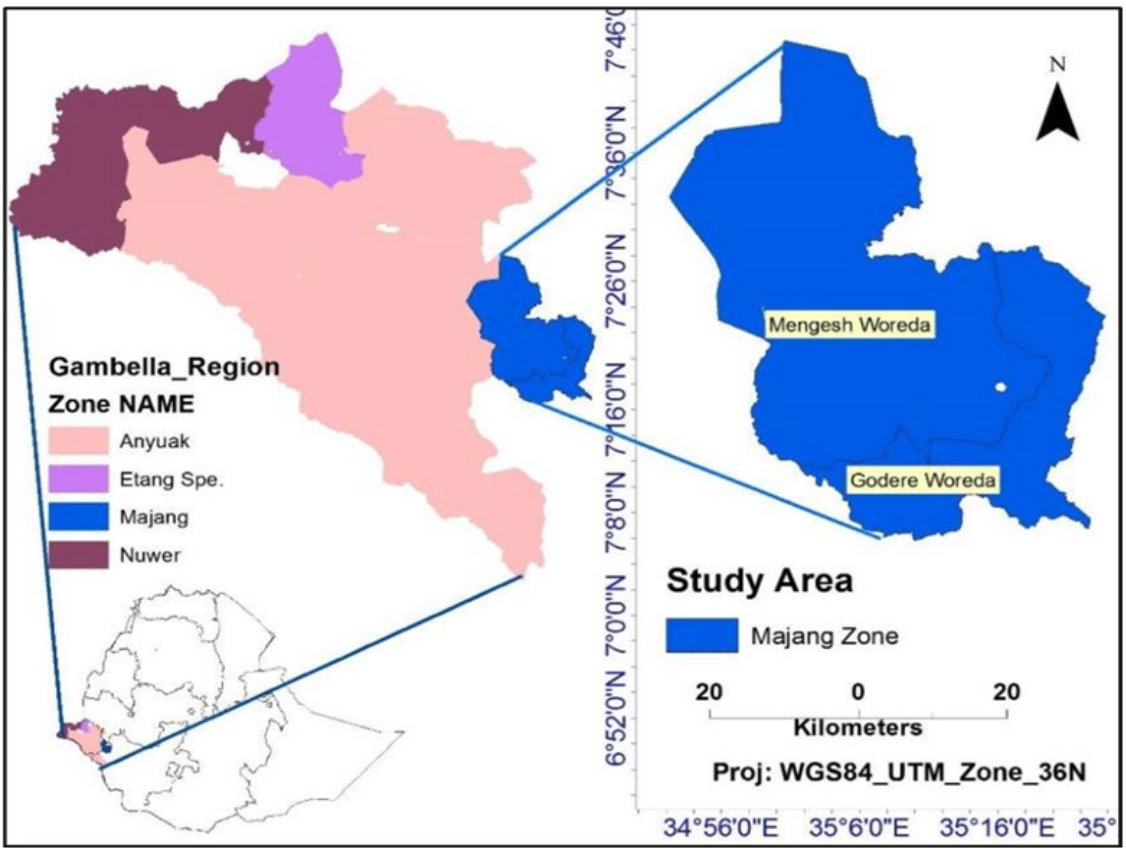

Figure 1. Map of the study area: Adapted from Mathewos & Bewuketu (2018)

2.2 Study Design and Data Collection Tools

The current research utilized an embedded design that sought to gather both qualitative and quantitative data either simultaneously or in sequence, while ensuring that the quantitative findings aligned with the qualitative findings (Creswell, 2009). Degefa (2006) recognized the mixed research design as the cornerstone of food security research, as it facilitates the examination of food security from various perspectives. This research employed household-based cross-sectional data. Consequently, both qualitative and quantitative approaches were implemented to collect data from primary and secondary sources. The methods employed for data collection included key informant interviews (KIIs), focus group discussions (FGDs), structured surveys, and desk reviews. To obtain information on food consumption, the WFP's standard survey module for the food consumption score (FCS) was utilized (WFP, 2008).

Primary data were collected using structured household survey questionnaires, FGDs, and KIIs from household respondents, rural extension workers, government and non-governmental organization (NGO) experts, and officials working on food security. Supplementary sources from published articles, periodic reports, and assessment were used to augment the secondary data requirement. Ten FGD sessions were held in each village, using the developed terms of reference administered to a group of 7-10 individuals. Both in-depth interviews and FGDs were conducted to triangulate the reliability and validity of the information gathered using other means.

2.3 Sample Size Determination

A multistage sampling procedure was implemented to select the households for the study. Initially, two districts, Mangeshi and Godere, were intentionally chosen since the zone comprises only these two districts, which share similar livelihoods and administrative boundaries. Subsequently, a systematic random sampling method was employed to select 10 villages—four from Godere and six from Mangeshi—out of a total of 32 villages, based on the premise that a substantial sampling ratio (approximately 30%) was suitable for small populations

(less than 1,000). The selected villages were determined based on prior discussions and assumptions regarding subsistence agriculture, the predominance of the Majang community, and their reliance on forest-based livelihoods. To ascertain the sample size for each village, the projected population (households) for 2022 was utilized to calculate the number of respondent households from each village, in accordance with the total household proportion share. The overall population and number of households in the 10 villages are estimated to be 15,826 and 3,557, respectively. Lastly, household respondents were randomly selected by employing the probability proportional to size technique for larger populations, as outlined by Cochran (1977).

$$n_0 = \frac{Z^2 pq}{e^2} \tag{1}$$

where, n_0 is the sample size and Z^2 is the abscissa of the normal curve that cuts off an area α at the tails ($1-\alpha$ equals the desired confidence level).

For this study, a 95% confidence interval was utilized, with the Z table value set at 1.96; e signifies the required level of precision; p (0.6) indicates the estimated proportion of an attribute or the total number of food-insecure households within the zone's population; and q is defined as 1-p, as noted in the reports of DRMFSS (2015).

According to the aforementioned formula, the sample size was calculated to be 369 households. Considering (Cochran, 1977) the sample size adjustment for instances where sample sizes exceed 5% of the population, the final sample size is established as follows:

$$n_1 = \frac{n_0}{1+\frac{n_0}{N}} \tag{2}$$

where, n_0 = the required return sample size, n_1 = the final sample size because the sample > 5% of the population and N = the population size.

Consequently, the final sample size was calculated as [369/1+ (369/3557)] =334. Due to the lack of complete information in certain household data, a few were excluded, resulting in 320 sample households forming the sampling unit for the final analysis.

2.4 Data Analysis

STATA version 13 was used to investigate the quantitative data on the variables influencing food security using both descriptive and bivariate econometric analytic techniques. To support and enhance the findings of the quantitative study, information from the responses was extracted, grouped, and synthesized to assess qualitative data.

Data was gathered using the Food Consumption Score (FCS) standard module in accordance with WFP (2008) criteria. The mean, frequency, standard deviation, and percentage constituted the descriptive statistics employed to evaluate the extent of influence of all the factors that affect household food security.

The correlates of household food security were examined using logistic regression (binary logit). The variables being studied and several related research articles, such as those by Moroda *et al.* (2018) and Hailu *et al.* (2018), were used to specify the binary logit econometric model. Unless the logit model is comparatively simpler mathematically, there is no strong argument for selecting it over the probit model.

The following mathematical presentation specifies the logit model's functional form:

Logit model:
$ln(\frac{p}{(1-p)}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon$

where, p is the probability of being food secure; β_0 is the intercept; $\beta_1, \beta_2, ..., \beta_0$ are the coefficients of the explanatory variables $X_1, X_2, ..., X_1$; and ε is the error term.

$$P_i = E(Y = \frac{1}{X_i} = \frac{1}{1+e^{-(\beta_0+\beta_j X_i)}}) \tag{3}$$

Substituting $(\beta_0 + \beta_j X_i)$ by Z_i, equation 3 becomes:

$$P_i = \frac{1}{1+e^{Z_i}} = \frac{e^{Z_i}}{1+e^{Z_i}} \tag{4}$$

where $P_i = E(Y = 1)$ is the probability that a household is food-secure. Z_i is a set of explanatory variables for the i^{th} household and β_0 and β_j are the parameters to be estimated.

If P_i indicates the probability of a household being food secure, as outlined in equation 2, then the probability of food insecurity can be articulated as follows:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \tag{5}$$

The odds ratio is calculated with equation 6:

$$L_i = ln(\frac{P_i}{1 - P_i}) = \frac{e^{Z_i}/1 + e^{Z_i}}{1/1 + e^{Z_i}} = e^{Z_i} \tag{6}$$

Hence, the logit model used to predict the odds of household food security is given by question 7.

$$L_i = ln(\frac{P_i}{1 - P_i}) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + u_i \tag{7}$$

Where, the coefficients of the variables to be estimated are denoted by β_i, where i = 1, 2, ... j, and β_0 is a constant. A vector of the explanatory variables is called X_i.

The Food Consumption Score (FCS) is derived from the variety of foods and the frequency of their consumption over a week-long period. The FCS is represented on a continuous scale, which is then used to classify households into established thresholds. Consequently, standard statistical measures, including the mean and variance, can be computed, allowing for the analysis of mean trends over time and across different categories. Additionally, frequencies and cross-tabulations can be established for the various food consumption groups.

In terms of methodology, the food items were categorized into eight standard food groups, with a maximum consumption frequency of 7 days per week. Following this, the frequency of consumption for each food group was multiplied by a designated weight, reflecting its nutritional value. These resulting figures were then aggregated to calculate the FCS.

The typical thresholds used by WFP (2008) are 0-21 (poor), 21.5-35 (borderline), and >35 (acceptable). Nevertheless, for populations with a significant frequency of oil and sugar intake (daily or nearly daily), alternative cut-off points are suggested as follows: 0-28 (poor), 28.5-42 (borderline), and greater than 42 (acceptable) (Tesafa *et al*., 2022; WFP, 2010). Because oil and sugar are consumed daily by people in almost all parts of Sub-Saharan Africa, including Ethiopia, the latter cut-off categories were used to set the FCS categories of the sampled households (WFP, 2008).

$$FCS_h = \sum_{i=1}^{n} w_i D_i \tag{8}$$

where FCS_h is the food consumption score of household h, w_i is the weight of food group i, and D_i is the number of days of consumption in the last seven days.

2.5 Definition and measurement of the study variables

Dependent variable

The household food balance sheet, along with another method for assessing food consumption (measured in kilocalories/day/AE), is widely acknowledged as the primary approach utilized in most studies to evaluate food security (Feleke *et al*., 2013). Furthermore, as stated by the WFP (2008), the Food Consumption Score (FCS), which assesses both caloric intake and the quality of the diet at the household level, is a recognized technique for determining food security. Consequently, the food security status of households is ascertained through the FCS. To classify families into three distinct food consumption categories, the household food consumption score is analyzed against established cut-off points:

0-28: Poor
28.1-42: Borderline
42: Acceptable

These groups reflect the food consumption status of the surveyed households. When determining the threshold cut-off value for food security, the assumptions of the WFP (2010) and Tesafa *et al*. (2022) were considered. As the value of the FCS falls between 0 and 112, one finds an FCS with a zero value, and an FCS of 112 is the maximum score (which means that all food groups were consumed by all seven days by household members).

Furthermore, by establishing 42 as the threshold for the Food Consumption Score (FCS), households

were categorized into food secure and food insecure groups to evaluate the risk factors associated with food insecurity. Consequently, any household with an FCS of 42 or below was classified as food insecure, while those with an FCS of 42 or above were considered food secure. Thus, when food security is confirmed, the dependent variable, which indicates food security status, is assigned a value of 1 (greater than 42), and if it is not confirmed, it receives a value of 0 (less than or equal to 42). A satisfactory percentage indicates food security, whereas the proportion of the population experiencing low and borderline food security reflects the prevalence of food insecurity (WFP, 2010).

Independent variables

***Age of household head (AGE)*:** A continuous variable quantified in years. It is anticipated that younger households will exhibit superior food security.

***Sex (SEXH)*:** This is a binary variable posited on the assumption that male-headed households have a higher likelihood of achieving food security.

***Family size of households (FSZH)*:** Family size denotes the total count of individuals within a household. This is a continuous variable. It is hypothesized that larger families, due to having members of productive age, engage in a variety of productive endeavors both on farms and in off-farm activities to aid in achieving food security.

***Marital status of household (MSTH)*:** This is a categorical variable that categorizes households as married, unmarried, divorced, and widowed. Married people are assumed to be better able to fulfil their food needs than single people.

***Dependency ratio (DEPR)*:** This variable is measured on a ratio scale by dividing the total household size by the number of individuals working. High dependency ratio indicates less probability of being food secured (Fekadu & Mequanent, 2010; Feleke *et al*., 2003).

***Educational Status of Household (EDHH)*:** Educated members of a household were hypothesized to remain food secure. The variable was measured on a dummy scale, denoted as 1 if the household had attended formal schooling and 0 if not.

***Income diversity (INCD)*:** This variable is expressed in categorical scales, based on the sources of income available to households. The availability of diverse incomes to a household secures the purchasing power of food and other necessities. This aspect is strongly related to food security.

***Landholding Size (LHSH)*:** Landholding size is measured in hectares. Households with large amounts of fertile cultivated land are expected to have a greater probability becoming food secure.

***Livestock assets (Tropical livestock unit, TLU)*:** The size and type of livestock owned assumed to increase food security.

***Oxen ploughing of farmland (OXPL)*:** The practice enables to retain the advantages of time, labor, and energy. Hypothetically, it has a positive correlation with household food security.

***Agricultural extension service (AEXS)*:** Technical visit by experts assumed to increase the chance of being food secure.

***Improved seed use (IMPS)*:** dummy variable. Farmers who utilize improved seeds have a greater probability of securing food than those who are unable to use improved seeds.

***Fertilizer use (FRTU)*:** It was measured on a dummy scale with values of 1 and 0 for yes and no answers, respectively.

***Pesticides/Fungicide Use (PEST)*:** It is expected to increase the probability of food security. This was measured using a dummy scale.

***Veterinary service (VETS)*:** A dummy variable denoted 1 for yes and 0 otherwise, where service provision supports attaining food security.

***Irrigation use (IRRU)*:** A dummy variable that takes the value of 1 if irrigation is used to produce a crop and 0 otherwise. Irrigation reduces the dependency of farmers on rain and enables the efficient utilization of resources such as water, time, land, and labor to increase production.

***Farmers' Training Center (FTC)*:** It is hypothesized that an institution will make a positive contribution to food security. The variable is a dummy variable

that is measured as 1 for yes or 0 for no.

***Beehives possessed (BEHV)*:** A variable expressed on a ratio scale based on the number of beehives owned. Households with a greater number of beehives are expected to become more food-secure.

***Access to Credit Service (ACSV)*:** It is a dummy variable that has a value of zero if the household does not accept credit and one if they do. Therefore, the likelihood of food security is higher for a household that has access to finance.

***Cooperative Membership (COOP)*:** This is a dummy variable that positively correlated with food security.

***Off-farm income (OFINC)*:** Income is measured in terms of birr and is therefore a continuous variable. Off-farm income is positively associated with household food security.

***On-farm income (FAINC)*:** It is measured in a manner similar to that for off-farm income. The a priori assumptions about food security were positive.

3 Results and Discussions

3.1 Socioeconomic characteristics of respondents

Tables 1, Figure 2, and Figure 3 present the households' social and economic characteristics. The research involved 320 rural households, the majority of which (90%) relied on agriculture as their major occupation to fulfill their livelihood. Approximately 79% of them were married, and 88% were male-headed households, indicating the dominance of male households in the farming community.

The average age of the households involved in the study was around 40 years, with the youngest participant being 18 years old and the oldest participant being 75 years old, respectively. On average, a household is composed of five family members, with a family size on par with the national average. Moreover, the mean landholding size (2.63 ha) of households in the study area was threefold higher than the Ethiopian CSA (Regassa *et al*., 2013) national (0.84 ha) and regional (0.63 ha) averages.

The mean annual farm and off-farm incomes of the households were calculated to be 20,273 birr and 495 birr, respectively; the mean per capita per annum was 4,054 and 100, respectively, for on-farm and off-farm incomes.

A multitude of factors contributed to the elevated levels of food insecurity observed in the research area, as indicated by the overall descriptive statistics. According to the food consumption indicators, the findings revealed that 53.12% of households were classified as food secure, while 46.88% were deemed food insecure. The average percentage of dependent members within households was higher (108%) in the study area, with the maximum percentage soaring to 250%.

Table 1. Descriptive statistics of the variables on the ratio scale

Variable	Obs	Mean	Std. Dev.	Min	Max
Age of the Household Head	320	40.36	11.33123	18	75
Family Size of the Household	320	4.99	1.80208	1	10
Dependency Ratio (%)	320	108.65	63.48359	0	250
Food Consumption Score	320	44.34	15.43502	9	108
Landholding Size	320	2.63	2.163528	0	13
Tropical Livestock Unit	320	.59	.9519454	0	4.2
Beehives possessed	320	5.00	10.45847	0	50
Off-farm income	320	495	1590.34	0	8000
On-farm income	320	20273.38	14810.23	0	49650

Source: Own survey data

3.2 The food security status of respondents

The results of the descriptive analysis further clarified that among the total households surveyed, around 88% were married, 8% were single, 2% were divorced, and 2% were widowed regarding their marital status. Regarding their occupations, 89.7% of the household respondents depended solely on agriculture, the remaining 9.7% on agriculture and trade, and 0.6% on other forms of income activities.

In addition, 57.81% had not attended formal education, and 42.19% had attended elementary education (Figure 2). Almost three-fourths of the respondents claimed the absence of services and technologies that support agriculture.

Accordingly, approximately 60.94% of them did not receive agricultural extension service contact, although FTCs were constructed in their villages (60.62%), were not provided with improved seeds (74.38%), not supplementing their crop production using traditional irrigation schemes (87.19%), not involved in cooperative activities (83.13%), inaccessible to veterinary services (80%), unable to prepare and apply fertilizers (86.56%), cannot plough (66.25%) with oxen, unable to access credit services (82.19%), and in short of purchasing and applying chemical pesticides (67.50%).

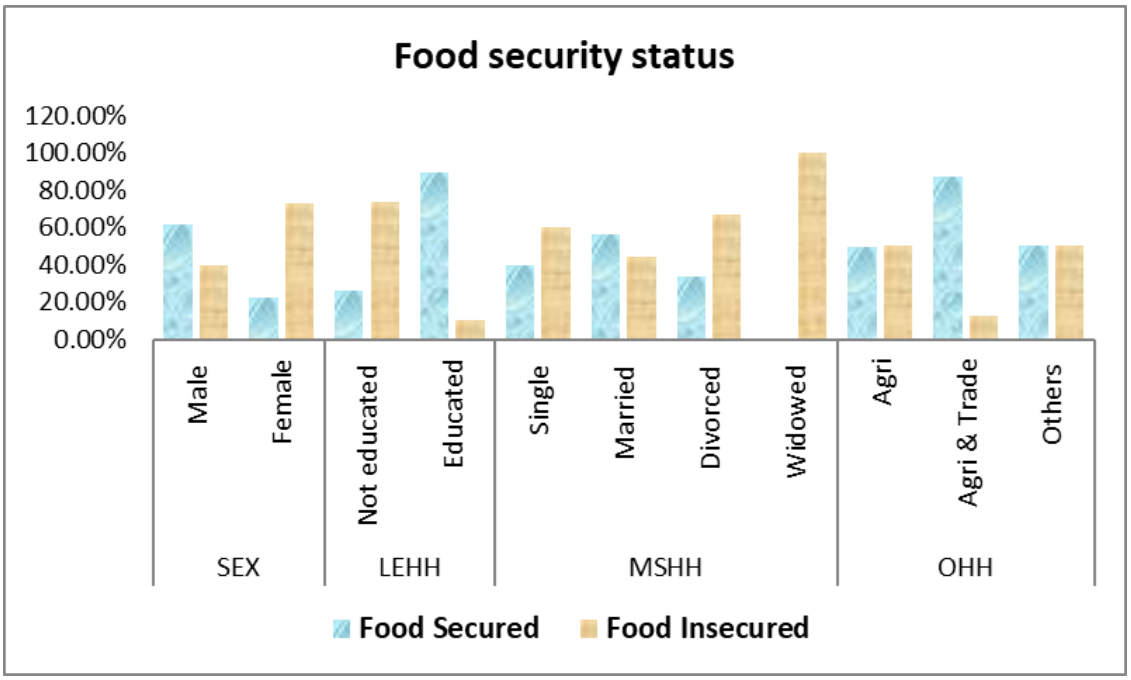

Figure 2. Descriptive statistics on the food security status of respondents
NB: LEHH-Level of Education, MSHH-Marital Status, and OHH-Occupation of Household Head.

The cross-tabulation results showed that among food-secure households, 91.18%, 92.94%, and 71.18% were male-headed, married, and had formal education, respectively. Within-group comparison ratios indicated that male-headed households (61.26%), married households (56.03%), and those who had attended formal education (89.63%) were more food secure. However, 22.39% of the females were headed, 31.58% were not married (single, widowed, or divorced), and 26.49% of those with no formal education were food secure.

Moreover, households with more than one occupation, agriculture, or trade (87.10%) had a greater chance of becoming food secure than those with only agriculture (49.48%) (Figure 3). Approximately 23.65% of the respondents participated and used inputs. A total of 125 households agreed to participate in extension services; 96% claimed food security, as did those who used improved seeds (87.80%), veterinary services (88.89%), organic fertilizers and access credit services (95.35%), pesticides (92.31%), cooperatives (95.52%), traditional irrigation (100%), and plowing with oxen (89.81%) (Figure 3).

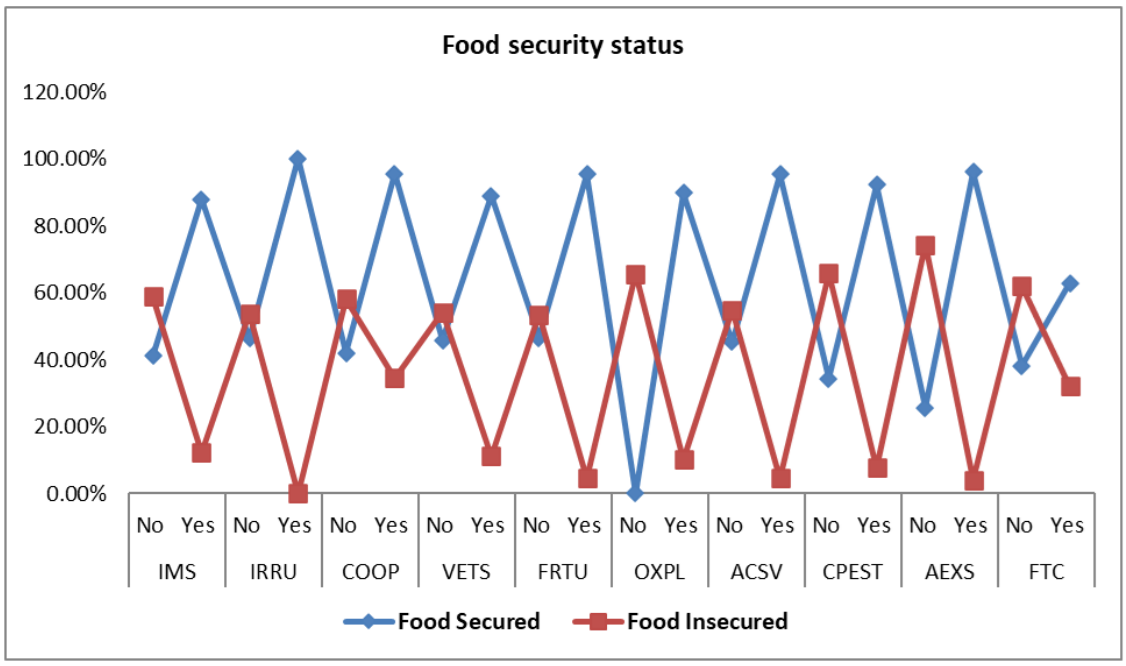

Figure 3. Food security statuses of the households as determined by dummy variables

NB: IMS-improved seed, IIRU-irrigation use, COOP-cooperative membership, VETS-access to veternary service, FRTU-fertiizer use, OXPL-oxen ploughing, ACSV-access to credit service, CPEST-pesticide use, AEXS-access to agricultural extension service and FTC-farmers' training center.

3.3 Econometric results of food security determinants

The food security status of households was evaluated based on the food consumption score categories established by the WFP in 2008. Ten of the 22 explanatory variables that were fitted to the designated model at different probability and influence levels demonstrated statistical significance.

The overall fitness of the model was checked using post-estimation tests (linktest, estat gof, estat classification, lsens, lroc). The link test is significant at _hat ($p<0.01$) and insignificant at _hatsq ($p<0.374$), indicating a perfect link between variables with no requirement of transformation. The chi-square test is also significant at 1% probability (pro > χ^2 = 0.0001). The goodness-of-fit test predicted the number of correctly predicted food-secure (95.88%) and insecure (96.67%) groups with prediction-based correctly classified values (96.25%) (Table 2).

The study used a logit model and Pearson's correlation analysis to evaluate food security status. Results showed that farm income, number of traditional beehives, formal education, agricultural land size, oxen plowing, livestock herds, access to extension support, and working family members have positive association with food security increment. However, the age and use of pesticides had significant negative predictive effects on food security status.

Table 2. The maximum likelihood estimates of the logistic regression model

Variables	Coef.	Robust Std. Err.	P value
Age of household head	-.1091**	.0483	0.024
Sex of household head	-.5101	.9599	0.595
Family size	.6119*	.3353	0.068
Marital status of household head	.9311	.8595	0.279
Dependency ratio	-.0092	.0075	0.219
Education level of household head	2.138***	.8174	0.009
Occupation of household head	-2.743	2.347	0.242
Land holding size	1.489***	.4764	0.002
Livestock ownership (TLU)	.9674**	.4936	0.050
Oxen ploughing	2.237**	1.023	0.029
Veterinary services	-1.061	1.192	0.373
Crop pesticides/fungicide	-2.071**	1.001	0.038
Farmers training center	-.5206	.6693	0.437
Agricultural extension service	2.469***	.9159	0.007
Fertilizer use	.7226	1.310	0.581
Improved seeds use	-.2208	.6414	0.731
Beehive owned	.1014**	.0459	0.027
Access to credit service	-1.613	1.518	0.288
Cooperative membership	1.872	1.333	0.160
Off-farm income	.0006	.0006	0.329
On-farm income	.0001***	.00003	0.003
_cons	-3.682	3.858	0.340
Number of obs = 320		Log likelihood = -35.181077	
Sensitivity (Food secured) =95.88%		Pseudo R^2 = 0.8409	
Specificity (Food insecured)=96.67%		LR $\chi^2(2)$ = 372.00	
Correctly classified=96.25%		Prob > χ^2 = 0.0000	

Source: Own survey data

NB:***, **, and * denote very highly significant, highly significant and significant*

The findings presented in Table 2 demonstrate that the age of a household is inversely associated with food security. The negative coefficient signifies a statistically significant relationship (p<0.5) that is negative in nature between the age of the household and its food security status. With other factors held constant, the results showed that households became 0.1091 times less food secure as they got older (one additional year to live). The result is in agreement the work of Mohammed *et al*. (2021), Sani & Kemaw (2019b), and Hailu *et al*. (2018). These groups of people support their assertion that older households increase the dependency ratio in the household, and since household heads are younger, they are more likely to be physically strong and aspire to participate in diverse income-generating activities. In contrast to this research, Awoke *et al*. (2022) reported that age has a positive relationship with food security, given that the experience gained and wealth accumulated over time enables households to be more food secure.

The correlation between family size and food security is rarely positive in studies concerning food security. Nevertheless, the findings of this study indicate a positive and statistically significant association at the 10% probability level. Consequently, an increase of one unit in the number of families enhances the

food security status of households by 0.6119 units, assuming other variables remain constant. This can be explained by the fact that households with larger family sizes, particularly when they consist of active adults, can contribute more labor to agricultural tasks, thereby boosting production and productivity. Consistent with this, the research conducted by Alemu (2013) demonstrated that a greater number of family members facilitates increased labor for production and positively correlates with the food security status of households.

Education is among the priority factors, as it contributes to the majority of the participants' efforts to improve their attainment of food security. Educated households tend to have more capacity to work efficiently by receiving and adopting improved technologies, participating in diversified income-generating activities, planning their working activities, keeping records of important events, and having knowledge of food and nutrition to smoothen their food basket requirements. As previously hypothesized, education has significance at the 1% probability level, with a coefficient portraying an almost 2.14 unit folds greater chance of being food secure than people who did not attend school. There was also a strong positive correlation (0.63) between these two factors. In support of our findings, Dagne (2016), Olayemi, (2012), and Mbukwa (2013) justified the necessity of formal education to enhance households' food security status.

The availability and size of agricultural land are the most basic asset endowments for agriculture-based rural livelihoods. In the Majang zone, land ownership is crucial for households, not only for agricultural activities, but also for providing forest-covered land for traditional beehives, a major component of their income source. Nearly 92% of the sampled households verified that agriculture was their primary mainstay. The results showed statistical significance at the 1% probability level (Table 2). Interpretively, possessing one more hectare of agricultural land increases the probability of becoming more (1.489 units) food secure. The correlation analysis results confirmed the existence of a positive and strong (72.41%) correlation between food security status and landholding size. Numerous studies (Tesafa *et al*., 2022; Agidew & Singh, 2017; Ahmed *et al*., 2018; Mequanent & Esubalew, 2015) conducted in rural contexts inseparably support the results of this research.

Livestock production plays an integral role in rural households' lives. Even though the average TLU of the studied households remained at a few units (0.59), the results showed a significant contribution of livestock ownership to food security. The findings indicate that food security increased by 2.631 units if the household owned one additional livestock while keeping other factors constant, which is significant at a 5% probability. A study in the Gambella region of the Lare district by Boum (2013) reported similar findings in which households with a unit higher TLU were found to be 0.863 units more food-secure. Other studies have confirmed the existence of a positive association between livestock size in TLU and food security (Mohammed & Mohammed, 2021; Misgina, 2014; Siraje & Bekele, 2013).

The findings indicated that only a limited number of households within the study area possessed both access to and proficiency in utilizing oxen for plowing; those who did experienced the most significant advantages. According to this hypothesis, farmers employing oxen for plowing their fields have a 0.9674 unit greater likelihood of achieving food security compared to those who do not. Furthermore, it is anticipated that farm revenue will have a highly significant ($p<0.003$) effect on the food security status in the research area, as it is thought to positively influence household food security. Consequently, for each unit increase in agricultural revenue, the food security status of households is expected to improve by a factor of 1.0001. The results from Pearson's correlation analysis revealed a strong and positive relationship (81.10%) between farm revenue and household food security status. The conclusions drawn by Awoke *et al*. (2022), Dagne (2016), Hussein & Janekarnkij (2013), and Etxegarai-Legarreta and Sanchez-Famoso (2022), who documented a positive and significant effect of on-farm income on the food security of rural households across various regions of Ethiopia, align with the findings of this study.

The majority of food security research conducted in Ethiopia has paid insufficient attention to factors associated with apiary activities overall, and no stud-

ies have been specifically carried out in the research area. Beekeeping is often complementary to agriculture, providing additional income opportunities for its practitioners (Hussein & Janekarnkij, 2013). Apart from generating income and serving as direct food, the existence of apiary farms in or around crop farms is expected to increase crop productivity because of the pollination role of bees. Research in Kenya (Etxegarai-Legarreta & Sanchez-Famoso, 2022) has shown that apiculture has a relatively higher and more reliable monthly income than animal and crop production. The number of traditional beehives possessed is believed to determine the income and wealth ranking in the Majang community. The traditional forest honey production type (Mutua, 2018) is the dominant and main source of income for indigenous Majang households because the yield and quality of honey are compromised by forest tree species and their abundance (Araya, 2020). As initially proposed, maintaining the other variables at their zero mean and unit standard deviation, the quantity of beehives owned had a positive and statistically significant impact on household food security status at the 5% probability level. An increased likelihood of owning more beehives enhances food security by 0.1014 units. Empirical findings from a study conducted in southern Ethiopia by Tarekegn & Ayele (2020) support the notion that a 1% increase in the number of beehives is expected to boost honey production by 10.14%, thereby raising the chances of achieving food security. Similar results from Uganda revealed an increase in honey production with an increasing number of hives kept and colonized per farmer (Mubarik & Buyinza, 2020).

Receiving agricultural extension services has vitality comparable to, if not greater than, that of attending formal schooling in terms of ameliorating the food security needs of agriculture-based households. The extension service is a package of improved technologies for the agricultural sector intended to facilitate the transfer of best agricultural practices and technologies to enhance the production and productivity of farming households.

The findings from the logit model suggest that involvement in agricultural extension programs is expected to raise the probability of achieving food security by 0.3435 units when compared to those who do not participate, which is statistically significant at the 1% level, assuming all other factors remain constant. In a similar vein, Awoke *et al*. (2022) and Sani and Kemaw (2019b) determined that providing technical assistance to farmers is crucial for improving the food security status of smallholder farmers. It was projected that resources such as fertilizers, pesticides, artificial insemination, and enhanced seed varieties would significantly contribute to the increase in agricultural production output.

The study examined the impact of improved seeds, fertilizers, and chemical pesticides on food security in households. It found that pesticide use was statistically significant, but not for chemical fertilizers or artificial insemination technologies. The results showed that a unit increase in chemical pesticide use increased food insecurity by 12.6%, contradicting the prior hypothesis. The study suggests that misconceptions about fertilizers and the inaccessibility and unaffordability of these technologies may have contributed to low adoption and reduced agricultural commodity yields.

4 Conclusion

This research aimed to determine the factors influencing and assess the food security status of rural households within the study area. It intended to investigate the elements that affect food security in the region. Furthermore, the outcomes of this study align with similar research conducted in Ethiopia and globally. The results revealed that 53% of the households were food secure, while 47% were food insecure. Although the use of pesticides and the age of the households had a negative impact on food security status, factors such as beehives, formal education, landholding, oxen plowing, livestock ownership, farm income, extension support, and family size made a significant and positive contribution to food security.

It was also claimed limited participation in extension services (39.06%), FTC (Farmer Training Center) coverage (39.38%), use of improved seeds (25.62%), irrigation (12.81%), participation in cooperatives (20%), access to veterinary services (16.87%), organic fertilizer use (13.44%), plowing with oxen (33.75%), and access to credit services (17.81%). Similarly, the small average tropical livestock unit

(0.59) suggests that contribution of the livestock sector to food and nutrition has received less attention. The authors also noted a complete absence of chemical fertilizer use in the study area.

Recommendations

Coordinated effort among national, regional, and local adminstrations and offices, such as those responsible for agriculture, climate and environment, forestry, disaster risk reduction and management, credit provision, education, and health, aligned with local development projects engaging in similar activities, must prioritize and implement effective food security policies and strategies in the study area. These should include small-scale irrigation schemes, production-enhancing technologies like certified seeds and modern beehives, land certification for better land use, and ensuring the welfare of households relying on forest resources. Local, development-centered plans are crucial for long-term success, as even non-significant variables can be important for food security fulfillment.

Equally crucial, traditional apiary activities, being the major income-generating non-timber forest product for most of the Majang community, require technical support to increase the honey collected per hive, improve product quality, and enhance the frequency of harvest. This should be coupled with the introduction and use of modern beehives. We recommend, as a priority and important research agenda, that comparative research be undertaken to determine the food security conditions of the Majang community and the so-called highlanders, as they may have distinctive livelihoods and require targeted intervention measures accordingly. Additionally, research that measures the resilience of households to food insecurity is recommended, as it provides a new perspective on how to effectively plan for and analyze the effects of shocks and stressors threatening the well-being of households or communities through a long-term development strategy.

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