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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, particularly for the least developed countries, although the challenge remains tough. The research was designed to analyze the food security status of households and its determinant factors in the Majang Zone. A multistage sampling was employed to select the 320 households. The study employed a mixed design that uses questionnaires, focus group discussions (FGDs), and key informant interviews (KIIs) to generate data. The data were analyzed using descriptive and binary logistic regression. The findings indicated that nearly 53% and 47% of the households were food secure and insecure, respectively. 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 ($p<0.10$) significantly and positively determine the household food security status, whereas age ($p<0.05$) and pesticide use ($p<0.05$) have negative relationships. A unit increase in the above factors is expected to improve food security by a fold of 0.1014, 2.138, 1.489, 2.237, 0.9674, 0.0001, 2.469, and 0.7226, 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

Ensuring food and nutritional security is the human and constitutional right of all citizens, though it remains a challenge, particularly in low-income countries. Food security is achieved 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). Globally, despite efforts to address food security crises, nearly 690 million people have been hungry, more than 250 million of whom live in Africa (FAO *et al*., 2021). It was suggested that the COVID-19 pandemic might have affected 83–132 million people worldwide by 2020. In Ethiopia, the number of poor and food-insecure people has remained very high, with an estimated 25 million people living at or below the threshold of survival (Diriba, 2020). Of these, 8.5 million were estimated to be severely food insecure in early 2020 (FAO *et al*, 2021; IPC, 2020). According to Luminița (2016), nearly 10.2 million people were in emergency food security settings. Approximately 52% and 36% of rural and urban populations, respectively,

consume less than the minimum recommended daily intake of 2100 kcal/person/day (Debebe, 2018). In response, the government tends to augment the food gap with food aid, where more than eight million people participate in PSNP transfers (Gilligan *et al*., 2023).

In Ethiopia, natural, social, physical, economic, and political factors are the main causes of food insecurity and unsustainable food systems (Endalew *et al*., 2015; World Bank, 2010; Regassa, 2011; FAO, 2010; Andersson *et al*., 2011; Eneyew and Bekele, 2012). Keller (2009) indicated that policy and program implementation gaps are another problem. For instance, drought, flooding, ecosystems, and biodiversity damage are claimed to be the driving factors (Simane *et al*., 2016). The FAO (2017) reported that famine and rain irregularities or seasonal disparities were the main causes of food insecurity in Ethiopia. Frequent floods and droughts, such as the latest El Niño damage in 2015 and 2016, have occurred throughout the country's history and have caused enormous losses in life and assets (FAO *et al*., 2017; UNDP *et al*., 2010; World Bank, 2017). Ethiopia has experienced more than 15 drought events over the last 50 years (Kasie, 2017). It has also been claimed that the country is structurally food insecure where food access has been impeded due to infrastructural, economic, and political instabilities, although food may be available at some point (Vedeld *et al*., 2007).

Natural resources misuse, drought, poor off-farm employment, diseases, poor access to the market and credit, poor access to drinking water and sanitation, policy gaps, and price inflation of food items were reported causes of food insecurity in the study area (Mathewos & Bewuketu, 2018; Guyalo *et al*., 2022; Girma & Muluneh, 2021). Despite the challenges in ensuring food security, little research has been conducted to address the core issues that trigger food insecurity. Most of the available evidence on food security comes from routine government documents and emergency assessment reports. This gap has resulted in duplicate efforts, inappropriate prioritization, and irregular planning and implementation of food security interventions. Furthermore, the livelihoods of many households in the area depend on forest and forest-related non-timber products; however, these issues are seldom addressed in scientific research. To address these issues, this study investigated the influence of food security determinants on rural households' food security status in the Majang zone.

2 Materials and Methods

2.1 Description of the Study Area

This study was conducted in the Majang zone of the Gambella Region of Ethiopia. The zone is located at latitude 7^o 4' 2.41" N to 7^o 46' 47.79" N and longitude 34^o 36' 30.54" E to 35^o 38' 48.00" E. The Zone has two districts, Godere and Mangeshi, which constitute the total study area (Figure 1).

The climate of the study area was hot and humid. Although there were no meteorological stations in the study area, the mean annual rainfall was estimated to be approximately 2100 mm. The mean temperature ranged between 20 and 33^oC. The area is characterized by a flat to gentle slope, with rocky steep and deep valleys along major streams and hills (Guyalo *et al*., 2022). The total land cover of the zone is 2252.79 km^2 (Central Statistical Agency, 2007). According to the CSA projected population census for the year 2022, the zone has a total population of 89,033, of which 46,119 are male and 42,914 are female. The estimated population density of the zone was 39.5 people per square kilometer. Godere and Mangeshi Districts have 12 and 14 villages, respectively, with projected populations of 61,079 and 27,954, respectively. Approximately 88% of the population is rural, with an average of 5.3 individuals per household and a large proportion under 20 years old (more than 60%).

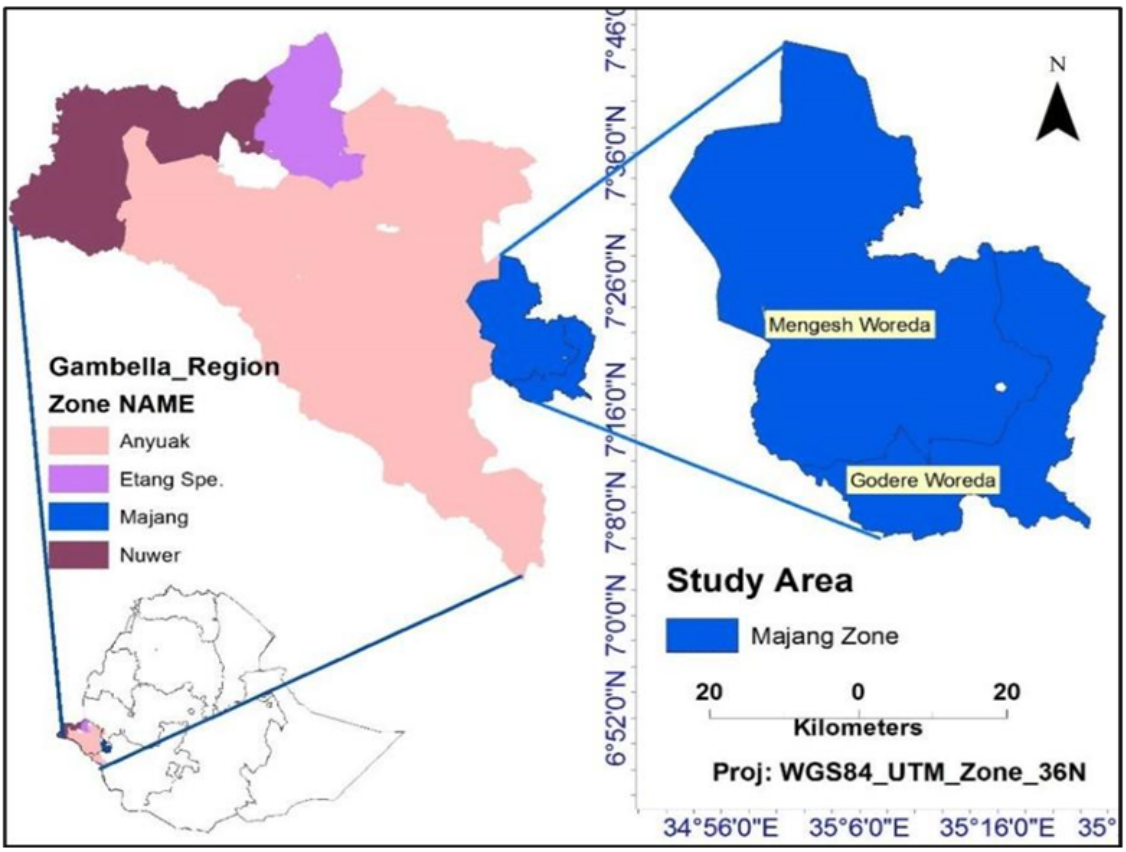

Figure 1. Map of the study area: Adapted from Mathewos & Bewuketu (2018)

2.2 Study Design and Data Collection Tools

The present study employed an embedded design that aimed to collect qualitative and quantitative data simultaneously or sequentially, but to ensure that the quantitative results were consistent with the qualitative results (Creswell, 2009). Degefa (2006) affirmed the mixed research design as the foundation of food security research because it allows for the analysis of food security in multiple dimensions. This study used household-based cross-sectional data. Hence, the data collection involved quantitative and qualitative methods from primary and secondary sources. The data gathering tools include structured survey questionnaires, focus group discussions (FGDs), key informant interviews (KIIs), and desk reviews. Food consumption data were collected using the standard survey module of the food consumption score (FCS) developed by the World Food Programme (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. Secondary data were collected from published articles, periodic reports, and assessment documents from government and NGO bureaus and offices. 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 adopted to select the study households. First, two districts, Mangeshi and Godere, were purposely selected because the zone has only two districts, and these districts share similar livelihoods and administrative boundaries. Second, a systematic random sampling technique was used to select 10 villages - four in Godere and six in Mangeshi - out of the 32 villages based on the assumption that a large sampling ratio (approximately 30%) was appropriate for small

populations (<1,000). The sample villages were included based on prior discussions and assumptions of subsistence agriculture, Majang community dominance, and attachment to forest-based livelihoods. To determine the sample size for each village, the 2022 projected population (households) of each village was used to calculate the respondent households from each village, based on the total household proportion share. The total population and households of the 10 villages are projected to be 15,826 and 3,557, respectively. Finally, household respondents were randomly sampled by applying the probability proportional to size technique to large populations, as described 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 research, a 95% confidence interval was assumed, and the Z table value was 1.96; e is the desired level of precision; p (0.6) is the estimated proportion of an attribute or all forms of food-insecure households that are present in the zone's population; and q is $1-p$, as highlighted in the reports of DRMFSS (2015). Based on the above formula, the sample size was 369 households.

Considering (Cochran, 1977) sample size correction for sample sizes exceeding 5% of the population, the final sample size is determined 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. Accordingly, the final sample size was [369/1+(369/3557)]=334. Owing to incomplete information in some household data, few were omitted, and 320 sample households composed the sampling unit for the final analysis.

2.4 Data Analysis

The quantitative data on the factors determining food security were analyzed using both descriptive and bivariate econometric analysis methods with STATA version 13. Qualitative data were analyzed by extracting, grouping, and synthesizing the information from the responses to substantiate and supplement the results of the quantitative analysis.

The Food Consumption Score (FCS) standard module was used to collect data, following the procedures given in the WFP (2008) guidelines. The descriptive statistics included the mean, frequency, standard deviation, and percentage, which were used to determine the level of influence of the determinant factors of household food security and to provide insight into different socioeconomic characteristics.

Logistic regression (binary logit) was used to investigate the correlates of household food security. The binary logit econometric model was specified based on the variables under study and in reference to multiple similar research articles, including those by Moroda *et al*. (2018) and Hailu *et al*. (2018). There is no compelling reason to choose the logit over the probit model unless its comparative mathematical simplicity. The functional form of the logit model is specified in the following mathematical presentation:

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 $X_1, X_2, ..., X_1$
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 is the probability that a household is food secure, as given in equation 2, the probability of food insecurity is expressed as follows:

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

The odds ratio is calculated with equation 6:

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

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

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

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

The Food Consumption Score (FCS) is calculated from the types of foods and the frequencies with which they are consumed during a seven-day period. The FCS is measured on a continuous scale that is subsequently subjected to categorization of households into predetermined thresholds. Hence, standard statistics, such as the mean and variance, can be calculated, and trends of means over time and across categories can be determined. Frequencies and cross-tabulations can be determined for the food consumption groups.

Procedurally, the food items were grouped into eight standard food groups with a maximum value of 7 days/week. Next, the consumption frequency of each food group was multiplied by an assigned weight, based on its nutrient content. These values were subsequently summed to obtain the FCS.

The typical thresholds used by WFP (2008) are 0-21 (poor), 21.5-35 (borderline), and >35 (acceptable). However, for populations that have a high frequency of oil and sugar consumption (daily or almost daily), alternate cut-offs are proposed as 0-28 (poor), 28.5-42 (borderline), and >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).

$$FCS_h = \sum_{i=1}^{n} w_i D_i \quad (8)$$

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

It is well known that most studies use two approaches to measure food security: the household food balance sheet and another method for assessing food consumption (food calorie intake in kilocalories/day/AE) (Feleke *et al*., 2013). Furthermore, the WFP (2008) claimed that the Food Consumption Score (FCS) is a prominent food consumption measurement tool and proxy for food security because it captures both caloric intake and diet quality at the household level. Hence, this study specifies households' food security status as the outcome variable determined by the FCS.

Procedurally, the household food consumption score is compared with predetermined cut-offs to classify the households into three food consumption groups:

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, to estimate the determinants of the probability that the households under study would be food insecure, they were categorized into food secure and food insecure households by taking 42 as the FCS threshold. Therefore, all households that scored an FCS of 42 or less were categorized as food insecure, and those with an FCS greater than 42 were considered to be food secure. Thus, the dependent variable, food security status, is assigned a value of 1 (>42) if food security is considered to exist, and 0 ($\leq$42) otherwise.

The proportion of the population with poor and borderline food security reflects the prevalence of food insecurity, and an acceptable proportion indicates food security (WFP, 2010).

Independent variables

Age of household head **(AGE):** This is a continuous variable measured in years. This study assumes younger households maintain food security better.

Sex of household head **(SEXH):** This is a dummy variable that influences households' state of food security. It is hypothesized that male-headed households are more likely to be food-secure.

Family size of households **(FSZH):** Family size refers to the total number of household members; hence, this variable is continuous. Given that they are of productive age, a large family is hypothesized to be involved in diverse productive activities on both farms and off-farm farms to support the fulfilment of 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. It is hypothesized that the higher the dependency ratio, the less the household becomes 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. It is hypothesized that households with large amounts of fertile cultivated land have a greater probability of being food secure than small landholders.

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

Oxen ploughing of farmland **(OXPL):** This variable enables farmers to gain the advantages of time, labor, and waste of food energy. Hypothetically, in this study, this variable has a positive correlation with household food security.

Agricultural extension service **(AEXS):** Technical visit experts increased the probability of being food secure. The variable is a dummy variable.

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):** An important dummy variable that takes a value of 1 for yes and 0 otherwise, which supports the food security attainment endeavor of households.

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 takes the value of one if the household takes credit and zero otherwise. Thus, a household with access to credit is more likely to be food-secure.

***Cooperative Membership* (COOP):** This is a dummy variable that takes a value of 1 for a yes response and 0 otherwise. This variable is positively correlated with food security.

***Off-farm income* (OFINC):** Income is measured in terms of birr and is therefore a continuous variable. Hence, it is hypothesize that the availability of off-farm income is positively associated with household food security.

***On-farm income* (FAINC):** This variable 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 mean age of the study households was approximately 40 years, with a minimum and maximum age of 18 and 75 years, 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.

The overall descriptive statistics provided evidence of the prevalence of high levels of food insecurity in the study area, and multiple factors contributed to this difference. The results revealed that 53.12% of households were food secure and 46.88% were food insecure, as determined by their food consumption measures. The mean percentage of dependent household members was greater (108%) in the study area, with the highest percentage reaching 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 descriptive analysis results further explained that of the total respondent households, approximately 88% were married, 8% were single, 2% were divorced, and 2% were widowed in terms of their marital status. Regarding their occupations, 89.7% of the household respondents depended solely on agri-

culture, 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%), unable to supplement their crop production using traditional irrigation schemes (87.19%), not involved in cooperative activities (83.13%), unable to obtain veterinary services (80%), unable to prepare and apply fertilizers (86.56%), unable to use oxen to plow their land (66.25%), unable to access credit services (82.19%), and unable to purchase and apply chemical pesticides (67.50%) (Figure 3).

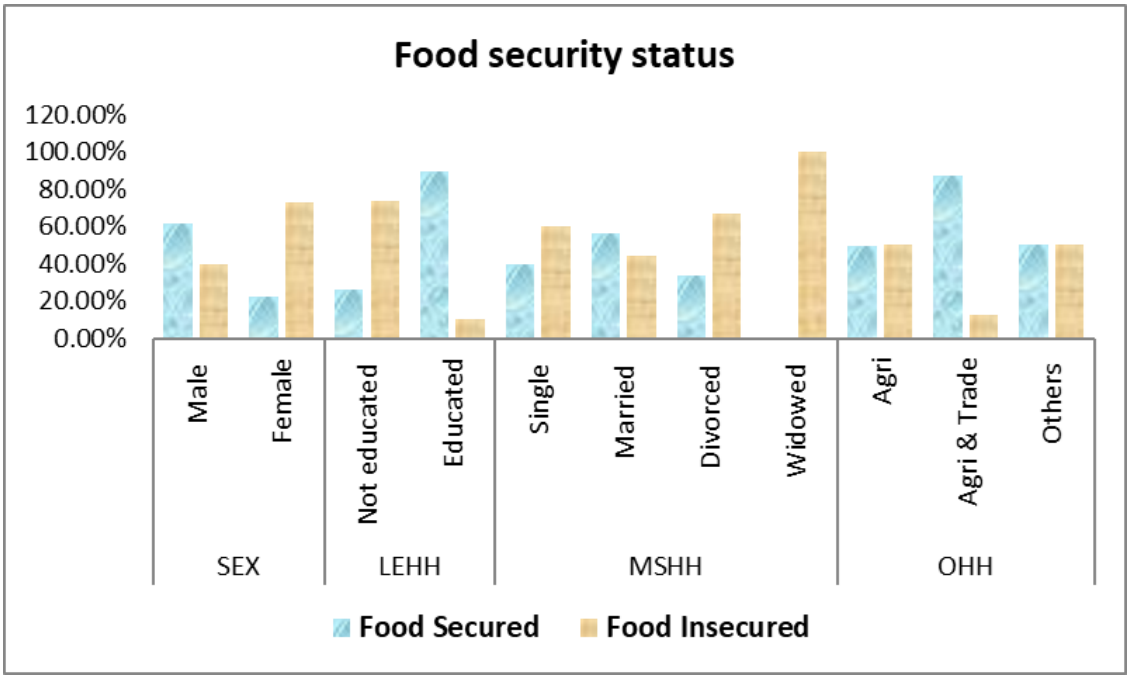

Figure 2. Descriptive statistics on the food security status of respondents
NB: LEHH-Level of Education, MSHH-Marital Status, and OHH-Occupation of Household Head.

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).

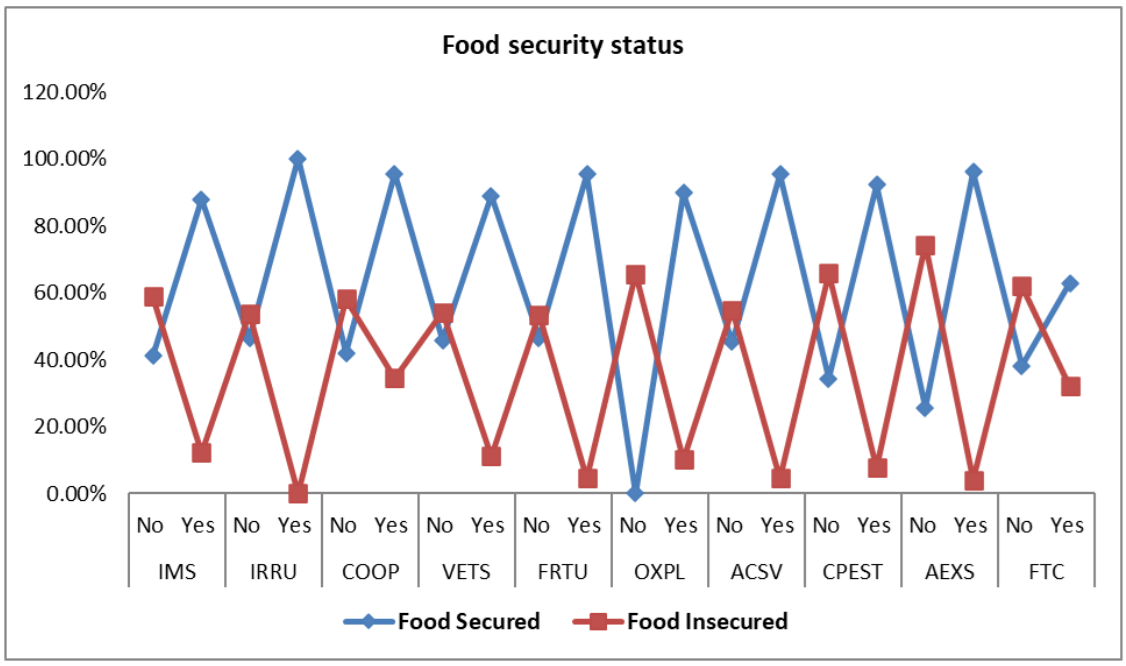

Figure 3. Food security statuses of the households as determined by dummy variables

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 determined based on the food consumption score categories previously established by the WFP (2008). In total, 22 explanatory variables were fitted to the specified model among, which 10 showed statistical significance at varying levels of probability and magnitude of influence.

The overall fitness of the model was checked using post-estimation tests (linktest, estat gof, estat classification, lsens, lroc). The link test result showed significant _hat ($p<0.01$) and insignificant _hatsq ($p<0.374$), indicating a perfect link between variables with no transformation, and the chi-square test was significant at 1% probability (pro > chi^2 = 0.0001). The goodness-of-fit test also estimated 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 were positively associated with food security. However, the age of the household head and the use of chemical pesticides had significant negative predictive effects on food security status.

The results in Table 2 show that household age is negatively related to household food security. The negative coefficient indicates the existence of a statistically significant ($p<0.5$) but inverse relationship between age and the food security status of households. 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). These findings are consistent with those of similar studies conducted in other parts of Brazil (Mohammed *et al*., 2021; Sani & Kemaw, 2019b; 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 re-

search, 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 association between family size and food security is seldom positive in food security studies. However, the results of this study reveal a positive and statistically significant relationship at the 10% probability level. Accordingly, a unit increase in the number of families increases the food security status of households by 0.6119 units, while the other variables are held constant. The justification for this could be that households with large family members, given that they are active adults, can supply more labor for agricultural activities, which can increase production and productivity. In line with this, the study results of Alemu (2013) revealed that having more family members helps provide more labor for production and has a positive association with the food security status of households.

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

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, the education status of the households was significant at the 1% probability level, with a predicted positive 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 a positive coefficient that was statistically significant 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).

Equally crucial as the TLU, is the oxen plowing of farms that are assumed to have a positive influence on food security. Nevertheless, few households had access to and experience with plowing with oxen in the study area; those exercising the practice benefited the most comparably. Meeting this assumption, plowing land with oxen enables farmers to be 0.9674 units more likely to be food secure than those who do not. Furthermore, as hypothesized to have a positive influence on household food security, farm income is predicted to be highly significant ($p<0.003$) in influencing food security status in the study area. Consequently, the food security status of households tends to increase by a factor of 1.0001 as farm income increases by one unit. Pearson's correlation results revealed a strong and positive relationship (81.10%) between farm income and household food security status. The results of this research are in agreement with the findings of Awoke *et al*. (2022), Dagne (2016), Hussein & Janekarnkij (2013) and Etxegarai-Legarreta and Sanchez-Famoso (2022), who reported a positive and significant influence of on-farm income on the food security of rural households in different parts of Ethiopia.

Most food security studies in Ethiopia have focused less on and incorporated factors related to apiary activities in general, and none has been performed specifically in the research area. Beekeeping tends to be complementary to agriculture and allows it to generate additional income for its producers (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 ani-

mal 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 hypothesized, keeping the other variables constant at their zero mean and unit standard deviation, the number of beehives owned had a positive and significant effect on determining household food security status at the 5% probability level. A greater probability of having more beehives increases food security by 0.1014 units. Empirical evidence from research conducted in southern Ethiopia by Tarekegn & Ayele (2020) agrees that increasing the number of beehives by 1% is likely to increase honey production by 10.14%, increasing the likelihood of becoming food secure. 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. Thus, this factor was expected to have a positive and significant impact on household food security.

The results of the logit model indicate that participating in agricultural extension packages is predicted to increase the likelihood of becoming food secure by 0.3435 units compared to non-participating units, which is statistically significant at the 1% level, all else being equal. Similarly, Awoke *et al*. (2022) and Sani and Kemaw (2019b) concluded that technical support for farmers plays an important role in enhancing the food security status of smallholders. It was anticipated that inputs such as fertilizers, pesticides, artificial insemination, and improved seeds would play a substantial role in improving 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 study aimed to identify the determinants and measure the food security status of rural households in the study area. It sought to examine the factors that govern food security in the region. Moreover, the results of this research are consistent with similar studies conducted in Ethiopia as well as across the world.

The findings indicated that 53% and 47% of the households were food secure and insecure, respectively. While pesticide use and the age of households negatively affected food security status, beehives, formal education, landholding, oxen plowing, livestock ownership, farm income, extension support, and family size had a significant and positive impact on food security status.

The study revealed 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 the potential 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

The coordinated effort among federal, regional, and local-level government agencies 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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