


Article

Determinants of Smallholders' Food Security Status in Kalu District, Northern Ethiopia

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Abstract: This study analyzed the determinants of rural households' food security in the Kallu district of the Amhara region, Northern Ethiopia. The study used primary data collected from 395 randomly selected rural households. The study employed descriptive statistics and a binary logit model to estimate the status and determinants of smallholders' food security, respectively. Of the total sample households, 47.30% are food insecure. The binary logit model results showed that sex and education level of the household head, livestock ownership, credit access, and technology adoption have positive and significant effects on food security, while age and market distance are negatively associated with the probability to be food secure. The results suggest that improving access to marketing and financial services will contribute to improving the food security status of smallholders.



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1. Introduction

Food security is among the major issues addressed in the international development agendas, including the sustainable development goals (SDGs). This demonstrates its equal importance for both developed and developing countries. A FAO (Food and Agricultural Organization) report indicated that, globally, 815 million people are undernourished, and the trend is even increasing compared to previous years. The majority of undernourished people are from developing countries [1].

Ethiopia is among Sub-Saharan African countries repeatedly mentioned in connection with the food insecurity problem. The daily calorie consumption in Ethiopia is below 2100 kcal/person/day [2]. By the year 2019, about 8.1 million people would require emergency food assistance. Although there have been efforts to achieve food security at the household level in Ethiopia, nearly 25 percent of the population still lives below the nationally defined poverty line [3]. Among others, land fragmentation, land degradation, crop failure, and high food price have contributed to a high prevalence of food insecurity in the country. Combining these aforementioned challenges with recurring droughts over the years has substantially eroded the productive resources of households, such as cultivation land, forests, and pastures, leading to high rates of environmental degradation and increased pressure on farmland. This, in turn, has aggravated the vulnerability of smallholder farmers in the country, especially during seasonal food shortages.

In Ethiopia, most food shortages have been geographically concentrated along with two broad belts. The first belt consists of the mixed farming production system area of the central and northern highlands. The second belt covers the low-lying agro-pastoral lands ranging from Wollo in the North, through Hararghe and Bale, to Sidamo and Gamo Gofa in the South [4]. The Amhara National Regional State belongs to the first drought-prone belt, which is characterized by rugged terrain, highly degraded soil, climate variability,

population pressure, deforestation, and overgrazing [5]. Therefore, ensuring food security remains to be the focus of the regional and federal government of Ethiopia.

The study area (Kalu) is one of the drought-prone districts of the Amhara region, where the majority of rural inhabitants' livelihood solely depends on subsistence farming and low productive livestock rearing [6]. Among others, the fastest-growing rural populations coupled with intensive crop cultivation results in severe land degradation and food insecurity in the study area [7]. To this end, a closer understanding of the level and causes of food security in the Kalu district can be considered as an important case study. Previous studies demonstrated that different factors affect the food security status of smallholders in different parts of the country [8–11]. This suggests that location-specific studies that account for unobservable differences in socio-cultural, institutional, and economic features will help government practitioners to make informed decisions. In this regard, using unique primary data from the Kalu district of the Amhara region, this study builds on the existing literature by adopting a consumption expenditure approach to measure food security. Specifically, this study aims to examine the status and determinants of smallholder food security in Kalu district, Northern Ethiopia.

2. Conceptual Framework

This section presents the conceptual framework of food security. By definition, food security refers to access to food by all people at all times for a healthy life [12]. This study adopts a conceptual framework (Figure 1) that accounts for this definition of food security [13]. The food availability dimension of food security refers to the extent to which food is within reach of the household. In this regard, the current study assumes that this is largely determined by crop production and livestock holding. Accordingly, livestock holding and factors that affect crop production are considered. Equally importantly, food availability is contingent on market access [13]. Another closely related concept is food access. Food access refers to the ability to obtain sufficient food. As a proxy to measure household level ability to buy food, off-farm income and credit access are considered. Likewise, the vulnerability of the household during food shortage affects the food security status of the household, which largely depends on the occurrence of shock, an education level (ability to analyze and forecast), and livestock holding [8]. Food utilization mainly relates to the quality of the diet. The choice of a quality diet can be mainly affected by gender and the education level of the household head. Moreover, food requirements can also be affected by age and gender [13].

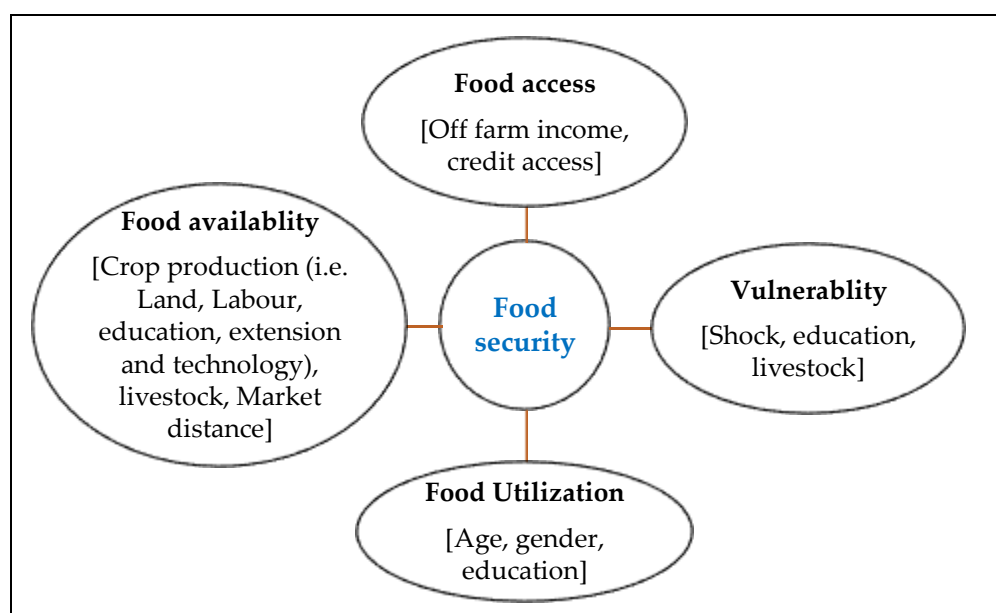


Figure 1. The conceptual framework for food security.

3. Methodology

This section describes the sampling method, the data, and methods used in the analysis.

3.1. Description of the Study Area

Kallu is one of the 22 districts in the South Wollo zone of Amhara National Regional State. The predominant (90%) source of livelihood for the majority of the population is a mixed farming system, i.e., crop production and livestock rearing. Despite its importance, agriculture in the district is challenged by factors such as moisture stress, soil erosion, shortage of arable land, draught power shortages, high incidences of pests and diseases, annihilating human and livestock diseases, the untimely supply of meager agricultural inputs, and poor weeds management [14]. This, in turn, has aggravated the food insecurity problem in the area.

The district has a total population of 227,488, out of whom 108,887 (47.86%) are women and 38,351 (16.86%) are urban inhabitants [15]. Kallu district has 35 rural and 6 urban kebeles. The district covers a total area of 851.54 km², out of which 34% is covered by crop while 56% is covered with bushes and shrubs [16].

3.2. Sampling Technique and Sample Size

The study employed a two-stage sampling procedure to draw samples representing rural households in the study area. In the first stage, four kebeles (namely Addis Mender, Addis Alem, Miawo, and Resa) were selected randomly from 35 rural administrative kebeles of the district. Kebele and district (also called woreda) are the smallest and the second smallest administrative units in Ethiopia, respectively. In the second stage, we employed systematic random sampling, taking one from every 13th in the sampling frame (i.e., 5282 households living in four selected kebeles). Accordingly, a total of 395 sample households were randomly selected from the total of four kebeles—i.e., proportional to the population size of the selected kebeles. The sample size was determined following Yamane [17].

3.3. Data Sources

Before data collection, the Kallu district office of agriculture provided a consent-based support letter from Bahirdar university. Accordingly, the district wrote a letter for respective kebeles recognizing the relevance of the study. This study used primary data collected from smallholder farmers. The data was collected using a well-structured questionnaire. The survey covered information including, but not limited to, age and sex of the household head, family size, educational level of the household head, cultivated land size, the total number of livestock in TLU, improved seed usage, off-farm income per AE, distance from the market center, use of farm credit, and insect and pest infestation. More importantly, a section of the survey deals with costs of consumption items, which was later used to calculate total consumption expenditure.

3.4. Variable Definition and Measurement

Table 1 below presents definitions and measurements of the outcome and explanatory variables used in this study. The selection of variables used in this study is based on previous studies (Table A2).

Table 1. Definition and measurement of variables.

Variable	Definition and Measurement
Sex	=1 if the head of the household is male and 0 otherwise
Age	Age of the household head (years)
Education	=1 if the household head is literate and 0 otherwise
Active labor	The number of family members in the age of 15 to 64 years
Cultivated land	Total cultivated land managed and owned in the last production season (ha)
Off-farm income	Total off-farm income in the last one year (thousands of birr)
Livestock	Total livestock holding of the household measured in tropical livestock unit (TLU)
Credit	=1 if the household head has access to credit and 0 otherwise
Market distance	Distance from home to the nearest market (km)
Extension contact	=1 if the household head has contacted by the extension agent and 0 otherwise
Technology adoption	=1 if the household has adopted improved seed and 0 otherwise
Shock	=1 if the household faces insect or pest infection and 0 otherwise

3.5. Method of Data Analysis

The study employed descriptive statistics (percentages, mean, and standard deviation) to estimate the status of food security in the study area. Similarly, inferential statistics (i.e., *t*-test and chi-square test) were used to show the association between the independent variables and the outcome variable.

Based on the cost of calories intake method, the food security line is defined by selecting a “basket” of food items usually consumed by the households. The amount of the basket is decided in such a way that the given bundle meets the predetermined level of minimum caloric requirement by the Ethiopian government (i.e., 2200 kcal) [18]. This “basket” is the estimated cost of the total food consumed over the last seven days of the survey period. This method yields a representative food security line in the sense that it provides a monetary value of the food security line. Following an approach suggested by the international food policy research institute (IFPRI), we classified the sampled households as food secure and food insecure using the minimum acceptable weighted average food requirement per adult equivalent (AE) per day. The adult equivalent conversion factor takes into account the age and sex of each household member [19].

In this study, the dependent variable (i.e., household food security status) is a dichotomous variable taking a value of 1 if the household is food secure and 0 otherwise. Hence, we have two appropriate models at disposal, namely, logit and probit. In practice, however, these models yield estimated choice probabilities that differ by less than 0.02, but the logit model is simpler in estimation than the probit model [20]. Therefore, this study adopted a binary logit model to identify the determinants of food security status (i.e., food secure and insecure groups). Following Gujarati [21], the logistic distribution function for determining factors driving the food security status of smallholder farmers can be specified as:

$$\pi(x) = \frac{1}{1 + e^{-z_i}} \quad (1)$$

where $\pi(x)$ is the probability of being food secure and Z_i is the log of the odds ratio.

$$Z_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n \quad (2)$$

where β_0 is an intercept; $\beta_1, \beta_2 \dots \beta_n$ are coefficients to be estimated; x_i refers to explanatory variables.

It should be noted that the estimated coefficients do not directly indicate the effect of change in the corresponding explanatory variables. Thus, the study estimates marginal effects to indicate the effect of change in explanatory variables on the probability (P) of the outcome occurring. The marginal effects are calculated using the linear probability index. In this context, the marginal effect can be interpreted as the change in the probability that the household will be food secure for a unit change in the explanatory variables.

4. Result and Discussion

Before embarking on the main findings of the study, it is important to describe the data and variables used in this study. The food security status of sample households was estimated from recall data of actual consumption expenditures over the past seven days from the survey period. The cost of the calorie was used to identify the food security line. The food security threshold line was estimated using the minimum level of required kilocalories (i.e., 2200 kilocalories per adult equivalent per day) taking into account the typical food diet of the sample households in the study area (Table A1). Accordingly, households whose total yearly consumption expenditure per adult equivalent is less than ETB 3989.77 (i.e., estimated food security threshold line in the study area) are considered as food insecure, and those households with annual food consumption expenditure above ETB 3989.77 per adult equivalent are labeled as food secure. Based on the calculated food security threshold line, 47.30% of sampled households were food insecure.

Table 2 below demonstrates a summary of the variables used in econometric estimation and tests if systematic relationships between socio-demographic characteristics and the food security status of the households exist. The results show that the food secure and insecure groups have a significant difference in most of the explanatory variables. For example, the first panel of Table 2 shows that nearly half of food secured households are literate while only a quarter of the insecure group is literate. Likewise, the second panel of Table 2 demonstrates that food-secure households own significantly larger productive assets (i.e., land and livestock) than their counterparts.

Table 2. Summary of explanatory variables by food security status.

Variable	Pooled Sample (N = 467)	Food Secure (N = 208)	Food Insecure (N = 187)	Mean Difference
Panel 1: Dummy variables				Chi-square
Sex (% of male)	73.99	85.58	61.55	29.81 **
Education (% of literate)	38.99	50.96	25.67	26.48 ***
Extension contact (% of yes)	53.67	65.38	40.67	24.24 ***
Tech. adoption (% of yes)	25.32	36.54	12.83	29.26 ***
Shock (% yes)	76.71	73.56	80.21	2.44 **
Credit (% with access)	21.77	25.96	17.11	4.53 **
Panel 2: Continuous variables				<i>t</i> -test ¹
Age (years)	45.92 (14.2)	44.90 (13.9)	47.07 (14.54)	1.51
Active labor (number)	2.85 (1.31)	3.09 (1.31)	2.58 (1.23)	−3.97 ***
Cultivated land (ha)	0.66 (0.38)	0.69 (0.39)	0.63 (0.35)	−1.68 *
Livestock (TLU)	1.32 (1.27)	1.56 (1.32)	1.03 (1.16)	−4.28 ***
Off farm income ('000 of ETB)	8.21 (16.39)	10.23 (18.18)	5.96 (13.85)	−2.60 ***
Market distance (km)	37.16 (25.65)	33.07 (20.4)	41.7 (29.8)	3.39 ***

¹ Notes: *t*-test is estimated as a mean difference between food insecure and food secured; ***, ** and * significant at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively; values in brackets refer to standard deviations.

Table 3 presents the main findings of this study (i.e., determinants of food security status). The estimated results revealed that the overall fitness of the model is significant at 1% (Prob > $\chi^2 = 0.0001$). The results show that by keeping other factors constant, on average, male-headed households are more likely to be food secure by a factor of 0.197 (19.7%) compared to female-headed households. A possible explanation for this can be because male-headed households have better access to social and physical assets that enables them to produce, purchase, and consume diverse and nutritious food products [9]. Another possible explanation can be because male-headed households can easily pull labor forces and have better farming experience than their counterparts. We also found that younger household heads are more likely to be food secure than otherwise, possibly because they tend to be physically strong to manage their farm and earn income from other nonfarm activities. A previous study in Nigeria [22] also stated that young household heads

are stronger and expected to produce more than older household heads. The education level of the household head is another variable that positively contributed to household food security. The justification for this result is intuitive in that literate households can make a more rational and informed decision in the production and marketing of agricultural products. This finding is in line with prior researches [6,19,20].

Table 3. Factors affecting the probability of household-level food security status.

Variable	Marginal Effect ¹	Std. Err.	Z-Value
Sex	0.197 ***	0.073	2.72
Age	−0.004 *	0.002	−1.79
Education	0.150 **	0.059	2.52
Active labor	0.035	0.025	1.42
Cultivated land	0.026	0.083	0.31
Off farm income	0.003	0.001	1.64
Livestock	0.054 **	0.025	2.12
Credit	0.125 *	0.066	1.89
Market distance	−0.002 **	0.001	−2.02
Extension contact	0.086	0.062	1.39
Technology adoption	0.158 **	0.070	2.26
Shock	−0.038	0.067	−0.56

¹ Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Dependent variable: =1 if the household is food secured.

A mixed agricultural farming system dominates the study area. Hence, livestock has a paramount contribution to household crop production and hence food security. In Ethiopia, the dominant share of smallholder farmers often uses oxen labor for plowing and threshing activities. Livestock is also a source of income (i.e., from the sale of livestock and livestock products), source of supplementary food, and means of transport. Besides, livestock serves as a coping mechanism during crop failure and other calamities. Accordingly, consistent with our prior expectations and findings of previous studies [23], households with better livestock holding are found to be more food secure than otherwise.

Credit access is another variable that positively contributed to food security, possibly by resolving the liquidity constraint of smallholder farmers. It is a common phenomenon that a considerable number of smallholders lack cash at the time where they need it most—i.e., planting time. During planting time, farmers face liquidity constraints to purchase agricultural inputs and for smoothening consumption. Our result also showed that access to credit had a positive and significant effect on household food security. This result conforms with previous findings [24,25].

As shown in Table 3, a 1 km increase from market centers decrease the probability of being food secured by 0.2 percent. There are two possible pathways that market access could affect household food security. If the household is a surplus producer and wants to sell its products, the household with better access (in this case, closer to the market) can benefit from lower transaction costs associated with transportation. On the other hand, if the household also wants to purchase crops to smoothen their consumption, households located closer to the market will benefit from the lower cost. Another possible justification could be because households located nearer to the market center may have a chance to participate in nonfarm activities, and hence are more likely to have more access to food [22,26,27]. Results of this study also demonstrated that agricultural technology adoption has a positive and significant effect on household food security status. The results suggest that those households who adopted improved seed obtained higher yield and hence are more likely to be food secure than their counterparts. This result is in line with previous studies that claim the adoption of agricultural technologies has a positive effect on household food security [26,28].

5. Conclusions

Food insecurity remains the main development agenda in Ethiopia. The causes and extent of the food insecurity problem in the country differ spatially. This study, therefore,

attempted to examine the status and driving factors of food security in the Kalu district of South Wollo zone, Amhara region. The study showed that 52.70% of sampled households were food secure while the remaining 47.30% are food insecure. There is no single set of solutions to resolve the problem of food insecurity everywhere. To this aim, the binary logit model results showed that the sex of the household head, education, livestock ownership, credit access, and technology adoption have significant effects on the probability that the household will be food secured. These results have important implications. Specifically, the results suggest that female-headed households are less likely to be food secured than otherwise and hence need affirmative action (e.g., through strengthening access to social and physical capital for women) for inclusive wellbeing. The result also demonstrates that in a mixed farming system, farmers can keep the balance between crop and livestock to attain food security. Output and financial markets were also found to have a significant effect on household food security. Hence, stakeholders (mainly financial institutions) should promote access to financial markets through capacity building (e.g., training and material/in-kind support). Likewise, the local and regional governments can improve the role of market access for food security by constructing all-weather roads connecting kebeles to nearby markets. Last but not least, the results suggested that facilitating access to improved agricultural technologies will help smallholder farmers to improve their food security status. Specifically, assuring an on-time supply of demand-driven agricultural technologies through the existing channel of agricultural cooperatives or the private sector (e.g., trained rural youths or rural agricultural input suppliers) will have a role in reducing rural poverty in Ethiopia in general and in the study area in particular. This will be in line with the efforts by governmental and non-governmental organizations towards promoting agricultural technologies as a means to alleviate the problem of food insecurity.

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Appendix A

Table A1. Estimation of food security line per year (ETB).

Food Item	Calori per Kg or Lt [A]	g/mL Consumed per Adult per Day [B]	Calori per Adult/Day [C = ((A/1000) × B)]	Calori per Adult/Day after Scaling up [D = (C × 2200/1530)]	Calori Share (%) [E = (D/2200) 100]	Mean Price per Kg or Lt (ETB) [F]	Value of Food Security Line per Year (ETB) G = [(B/1000) × F × 365]	Exp. Share (%) H = G/3989.7) × 100
Teff	4428	1.71	7.57	12.51	0.57	32	19.97	0.50
Sorghum	3390	308.57	1046.05	1727.97	78.54	15	1689.42	42.34
Maize	3500	24.66	86.31	142.58	6.48	12	108.01	2.71
vegetables	650	14.91	9.69	16.01	0.73	32	174.15	4.37
Chickpea	3640	0.27	0.98	1.62	0.07	30	2.97	0.07
Pepper	400	18.56	7.42	12.26	0.56	85	575.82	14.43
Meat	1430	0.71	1.02	1.68	0.08	210	54.42	1.36
Butter	7170	0.43	3.08	5.09	0.23	350	54.93	1.38
Milk	610	1.1	0.67	1.11	0.05	23	9.23	0.23
Egg ¹	61	0.0196	0.00	0.00	0.00	5	0.036	0
Coffee	0	8.57	0.00	0.00	0.00	120	375.37	9.41
Salt	0	8.71	0.00	0.00	0.00	25	79.48	1.99
Sugar	3870	5	19.35	31.96	1.45	40	73	1.83
Edible oil	8850	15.29	135.32	223.53	10.16	80	446.47	11.19
Potato	770	4.03	3.10	5.13	0.23	20	29.42	0.74
Onion	400	22.9	9.16	15.13	0.69	30	250.76	6.29
Garlic	1490	1.41	2.10	3.47	0.16	90	46.32	1.16
Total			1331.83	2200.06	100.00		3989.77	100

¹ Egg is measured in number.

Table A2. Summary of empirical studies.

No	Author	Year	Study Area	Significant Variables
1.	[28]	2010	Ada Berga	Nonfarm incomes, land and livestock holdings, experiences in farming activities, water and soil conservation practices, and fertilizer use.
2.	[29]	2012	Kersa	Age of the household head, sex of the household head, household size in adult equivalent, total cropping land in ha, oxen owned, and remittances in Birr
3.	[30]	2013	Shashemene	cultivated land size, family size, total farm income, off-farm income, and livestock ownership
4.	[31]	2015	Boloso Sore	Family size, age of the household head and access to extension services, credit access, household income, oxen ownership, and cultivable land size
5.	[24]	2016	Hawi Gudina	Family size, livestock ownership, distance from market center, access to nonfarm activity, and cash crop production
6.	[26]	2017	North Ethiopia	Age of household heads, educational level, TLU, cultivated land size, access to credit, applying chemical fertilizer, and improved seeds
7.	[32]	2018	Werie Leke	age of household head, family size, irrigated land holding, market information, and credit utilization
8.	[27]	2019	Woliso	age of educational status of household head, livestock ownership, pesticide utilization, ceremonial expense and
9.	[9]	2019	Western Ethiopia	sex of household head and access to irrigation, age of the head of the household, cultivated land size, off farm and nonfarm income, and access to credit

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