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Household food insecurity and coping strategies in Southern Ethiopia

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Abstract

Background: Hunger and undernourishment are the main challenges of today's world and 960 million people are hungry and undernourished. Food insecurity is an enduring, critical challenge in Ethiopia. Majority of the previous studies overlooked relevant determinant factors which affect the occurrence of food insecurity. This study aims to investigate household level food insecurity determinate factors and coping strategies used in the study area.

Method: Explanatory and descriptive research was designed to assess household food insecurity and coping strategies in Analemno district of southern Ethiopia. A multi-stage purposive sampling technique was used for the purpose of this study. Two hundred households were selected systematically following list of food insecure households. Econometric models were employed using binary logit model. Household calorie acquisition was calculated to categorize households into food secure and food insecure status.

Results: The survey result showed that 64% of the respondents were food insecure. Variables such as agro-ecology, age and education status, number of oxen, soil and water conservation, amount of credit, cultivated land size and receiving remittance were negatively but significantly ($P < 0.05$) affected households' food insecurity level. Female and young groups of the community were more food insecure as compared to others groups. The community was coping food shortage by relying on less preferred and less expensive food followed by participating in off-farm activities and borrowing food. Households in the study area were utilizing less preferred foods to cope up food shortage and starvation.

Conclusion: Efforts of different developmental organizations should give due emphasis to household's wealth level, female-headed household and young and old-aged members of the community. Crop land production supported by modern agricultural technologies and information can reduce agricultural risks, and enhance productivity per unit land.

Keywords: Calorie acquisition, Coping strategies, Farmers' experience, Food insecurity, Logit model

Background

Hunger and undernourishment are the main challenges of today's world and 960 million people are hungry and undernourished [1]. The severity of the challenge is very high in developing and tropical countries [2]. Majority of the African countries has been hosting frequent and

sever hunger and undernourishment. Of the total African population, 27.4% is found under chronic food insecurity problem which is four times more than any other continent in the world [3]. Among the African countries, Ethiopia has the highest prevalence of undernourishment (32.1 million people) from Sub-Saharan Africa followed by Tanzania (15.7 million), Nigeria (12.1 million), Kenya (11 million) and Uganda (10.7 million) [4, 5].

The main cause of food shortage in Ethiopia is natural disaster, severe drought, flooding, insecurity, and conflict. These causes have been worsening and leading to

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rapid and large-scale displacement along the borders of Somali, Oromia, and SNNPR [6]. In the ever-continuing quest for finding a suitable and effective remedy against failure of rainfall, researchers have analyzed coping strategies that have been used by different communities from different production system for long periods [7, 8]. Rural households (HHs) in Ethiopia have been using food insecurity coping strategies such as selling of live animals to purchasing food grain, borrowing, participate in off-farm activities, seeking relatives and friends support, change in feeding habit, food for work, reducing the amount to be consumed [9–11]. The importance of focusing on those local indicators can help farmers to develop early warning systems which minimize the negative impact of factors such as climate change. Basically, others [8, 12, 13] have shown that inter-annual rainfall variability followed by extreme forage fluctuations can cause greater damage on the productivity of crops and livestock, and also further increase livestock population die-off.

Food insecurity is an enduring, critical challenge in the Federal Democratic Republic of Ethiopia [6]. Rural poverty and food insecurity were challenging for millions of people in the country. Fifty two percent of the country population is food insecure with an average HH consumption of 1770 kilocalories per adult equivalent which is less below national recommended daily kilocalories of 2100 [14]. In southern Ethiopia, on average, 22% of the total HHs lives below the food poverty line [15]. The situation is so much worse in zones such as Hadiya

[16]. For long, Ethiopian governments has been implementing policies and programs relevant for food security and nutrition including GTP 2010–2015, the agriculture sector policy and investment framework (PIF) and food security programs (2010–2014). In addition, more than 60 percent of the daily calorie intake in Ethiopia is derived from five cereal crops namely, teff, barley, wheat, maize, and sorghum. Food balance sheet shows, per capita supply of food for the 2017/18 period is 202 kg/year/person which is below the recommended rate of 218 kg/person/year [17]. There have been studies [18, 19] which deal about determinants and coping strategies of food insecure HH. However, those studies overlooked relevant variables such as agro-ecology, access to irrigation, soil and water conservation and non-farm income. Moreover, they did not consider the coping strategies index to examine how food insecure HHs mitigate food shortage. Therefore, this study aims to investigate HH food insecurity determinate factors and coping strategies of the HH to cope food shortage in the study area.

Materials and methods

Description of the study area

This study was conducted in Hadiya Zone, Ethiopia. It is 214 kms from the capital city, Addis Ababa. For the purpose of this study, Analememo district was selected and it is geographically located between 70° 54'- 70° 73' latitudes and 370° 89'- 380° 06' longitudes [20]. It consists of 27 rural Peasant Associations (*Kebeles*). Kebeles are

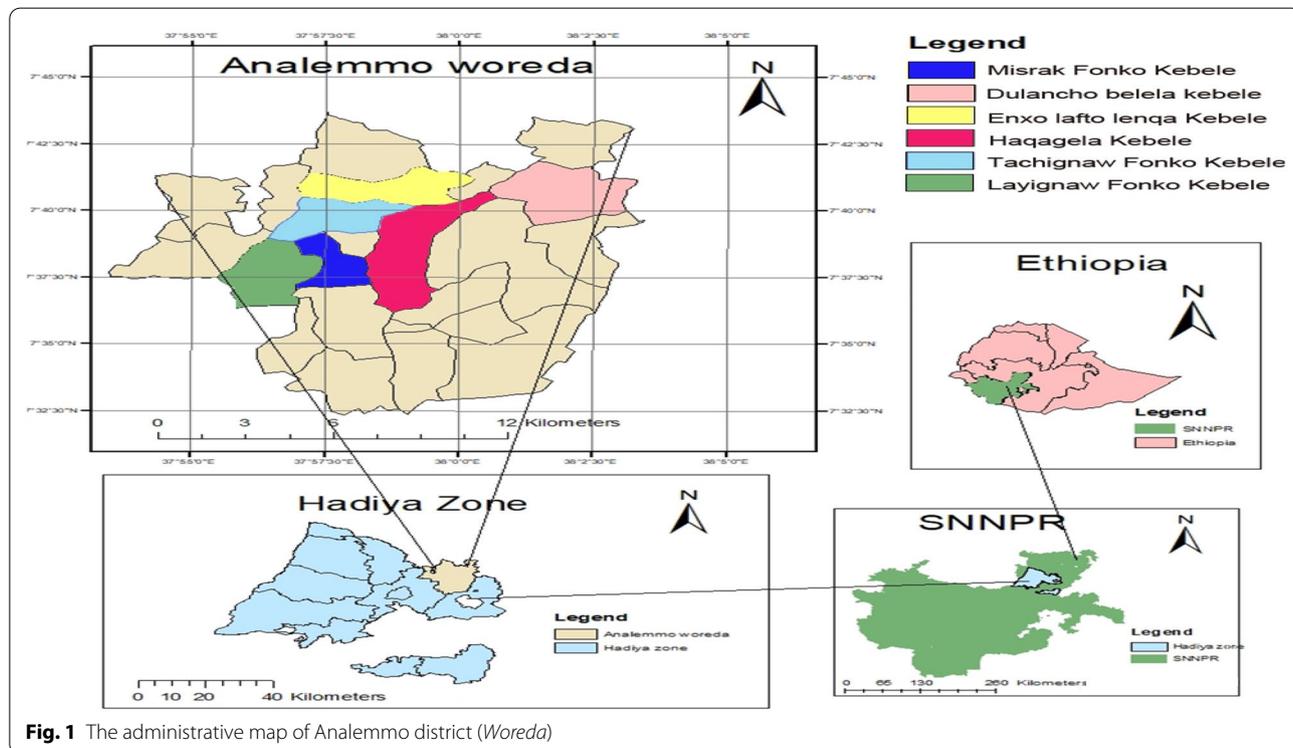


Fig. 1 The administrative map of Analememo district (*Woreda*)

the lowest administration level of the country. The district has two agro-climatic zones namely Lowland (*Kola*) and Midland (*Woina Dega*), covers 40 and 60 percent of the land mass, respectively. The totals HHs of the target population within the 27 kebeles are found to be 11,116 [20]. Mixed cropping system is majorly practiced in the district. The major cereal and pulse crops are teff, barley, wheat, maize; sorghum, bean, and haricot bean are produced commonly in long rain (Meher) season. The mean annual rainfall of the area ranges from 1000mm to 1400 mm, and the mean annual temperature ranges from 15 °C to 20 °C. The administrative map of Analemno district is presented in the figure below (Fig. 1).

Research design

For this study, descriptive and explanatory research design that followed a cross-sectional survey was employed. Households were selected based on three stage sampling design. The design was used to collect both qualitative and quantitative data. Participatory Rural Appraisal (PRA) tools that incorporated formal survey, Key Informants Interview (KII), personal observation, and Focus Group Discussion (FGD) were employed to triangulate the accuracy of the collected data.

Sampling techniques and sample size determination

The sampling was done following three stages. Originally, the kebeles within the district was categorized in to two major agro ecological categories i.e., midland and lowland. Then, among the two agro-ecological categories, two kebeles from the lowland and four kebeles from the midland were selected purposively based on the frequency of drought occurrence, level of food insecure and relative number of safety net program beneficiaries. Proportionally, majority of Ethiopian rural population dwell in midland agro-ecologies. The sample HH’s size was determined based on the formula by [21] as cited by [22] as follows.

$$n = \frac{N}{1 + N(e)^2},$$

$$n = \frac{11116}{1 + 11116(0.07)^2} = 200,$$

where *n* is sample size, *N* is the total population, 1 is the constant *e*=margin of error (*e*=0.07). Eventually, 200 HHs were selected from list of HHs dwell in the selected kebeles systematically to represent HHs in different kebeles of the district. The households were selected systematically following every 14th household from the list of HHs collected from all the six kebeles.

Data sources and data collection methods

Both primary and secondary data sources were used. The primary data were collected from sample HHs through formal survey. Semi-structured questionnaires in the form of paper were developed to get first-hand information about food security status and determinant of food insecurity. Furthermore, six FGDs and 11 KIIs were done. Secondary data were collected from different published and unpublished documents and used for interpretation and discussion purpose.

Data analysis

The collected and completed questionnaires were first checked and coded. Data were entered into computer and analyzed using STATA version 14 software programs after careful scrutiny. Data regarding HH food consumption level within 7 days were converted in to kilocalorie following nationally recommended kilocalorie by [23]. Household’s daily calorie intake per adult equivalent was calculated by dividing the HH’s daily calorie intake to the family size after adjusting for adult equivalent using the consumption factor for age–sex categories [24]. Households who consumed below this minimum requirement (i.e., 2100 kcal per adult equivalent per day) were categorized as food insecure and those HHs who consumed above the threshold were considered as food secure. Therefore, Out of the total 200 respondents, 128 of the total HHs were food insecure and the rest 72 were food secure (Table 1).

Coping strategy index (CSI) was calculated based on the ranks of local coping strategies adopted using Weighted Mean Score. A four-point scale with the scoring order of 3, 2, 1, 0 for frequently, sometimes, rarely and never was used to calculate frequency of HH reliance on various coping strategies [25].

$$CSI = N_3X_3 + N_2X_2 + N_1X_1 + N_0X_0, \tag{1}$$

where *N_i*=number of the HHs using a particular coping strategy and *X_i*=scoring order for frequency. The CSI was used in rank order to reflect the comparative position of each of the coping strategy in terms of use. Weighted Mean Score (WMS) was calculated:

Table 1 Description of the HH representatives and HHs food security status (*N*=200)

HHs food insecurity status	Frequency (%)	Mean	S.D	Min	Max
Food secure (FS)	72 (36)	2858.75	810	432	5271
Food insecure (FIS)	128 (64)	1465.11	422		
Total	200 (100)	1966.82	893		

$$WMS_i = \frac{CSI}{Z}, \tag{2}$$

WMS = weighted mean score Z = a total number of HH head and i = individual coping strategies.

Model specification

The dependent variable has a dichotomous nature. Binary logistic regression model was used to identify determinants of food security in the study area. The statistical similarities between logit and probit models make it difficult to choose between the two models. Maddala [26] indicated that logit model has the logistic distribution functions and probit model have cumulative normal functions. Furthermore, the logistic function has slightly heavier tails than the cumulative normal distributions. Therefore, binary logistic regression models were used (food insecure encodes '1' and food secure HHs encodes '0'). The functional form of the logistic regression model was taken from [27] and presented the equation as follows:

$$\left(P_i = e^{\left(Y = \frac{1}{x_i} \right)} = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1)}} \right). \tag{3}$$

Here P_i is the probability that a given HH is being food insecure. For simplicity, written as (1)

$$P_i = \frac{1}{1 + e^{-z}}, \text{ where } z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_n x_n. \tag{4}$$

The function of n explanatory variables i.e., Z is calculated as the summation of β 's at each exogenous variables (x). β 's are population regression coefficients that are to be estimated from the data. The probability that a given HH food secure is:

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

Therefore, the odds ratio in favor of food insecure is

$$\frac{P_i}{1 - P_i} = e^{z_i}. \tag{6}$$

Taking the natural logarithm of (4) we obtain,

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_{12} x_{12} + U_i, \tag{7}$$

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_i x_i + U_i,$$

where L_i is the log of the odds ratio, Z_i is the function of n explanatory variables, P_i is the probability of being food insecure, $1 - P_i$ is the probability of being food secure, β_0 is the intercept of the equation, $\beta_1, \beta_2, \dots, \beta_{x_i}$ and U_i are residual term and x_i 's are the exogenous variables included in the model.

Age of HH head (AHH)

It is a continuous variable measured in years of HH head. As ages of HHs increased, it is assumed that farmers could acquire more knowledge and experience easily. So, they adopted modern technology. They are more risk averter, and their chance to become more food secure increases with age [28]. It is expected a negative relationship between age of HH head and food insecurity level.

The education of HH head (EDUHH)

It is a continuous variable measured by year of schooling. Educated HHs easily adopt different farming technologies and close to technology updates which become make them more risk averse that strongly determines HH food security level [29]. In this study, HH head education level is expected to have a negative effect on the status of HH food insecurity.

Sex of HH head (SEXHH)

It is a dummy variable (i.e. 1 if it is female and 0 otherwise). Male-headed HHs have more access to agricultural technologies and off-farm activity than the female-headed HHs that make them involve in diversified income sources [30]. In this study, sex of HH head is expected to have positive effect on status of HH food insecurity.

Family size of HH head (FSHH)

It is a continuous variable that measures adult equivalent that live and depend in a single HH. An increase in HH family size implies that more people are depending on limited resource of a single HH [11]. In this study, family size is expected to have a positive effect on HH food insecurity.

Agro-ecology of land (AGRECO)

This is a dummy variable (0 for lowland, 1 for midland agro-climatic zone). Lowlands were more likely to be food insecure as compared to midland. Rural HH in the midland were producing enset, potato and sweet potato that had helped them to become drought tolerant [31]. In this study, midland is expected to have a negative effect on HH food insecurity.

The number of oxen (TNO)

It is a continuous variable measured in number. Oxen are the still the major source of agricultural power in most developing countries. Major successes of the agricultural activities are directly or indirectly supported by available oxen at HH level. Thus, the number of oxen available to the HH increases the probability of the HH being food secure [32]. It is expected that number of oxen owned have negative effect on the status of HH food insecurity.

Tropical livestock unit (TLU)

It is a continuous variable measured in TLU. HHs with large livestock size are less vulnerable to food insecurity [33]. It is expected that the number of TLU have negative effect on the status of HH food insecurity.

Use of chemical fertilizer (UCF)

It is a dummy variable taking the value of 1 if a farmer was being used fertilizer and 0 otherwise. It can increase agricultural productivity by boosting overall production and contributes to attaining food security at the HH level [11]. It is expected to have negative relationship between Uses of chemical fertilizer and status of HH food insecurity.

Drought-tolerant seeds (DRRESEED)

It is a dummy variable that takes a value of 1 if farmers used improved seeds and zero, otherwise. HH that uses improved seeds is expected to be more food secure than the non-users [31]. It is expected a negative relationship between drought-tolerant seeds and status of HH food insecurity.

Soil and water conservation measures (SWC)

It is a dummy variable 1 if a HH is practicing soil and water conservation and 0 otherwise. Soil and water conservation practices have been helping farmers to mitigate land degradation problem through maintaining soil fertility, which increases crop production and increases soil fertility. Erosion and soil degradation are among the major constraints of crop production [31]. Soil and water conservation has negative effect on status of HH food insecurity.

Distance to nearest market (DISTMKT)

It is a continuous variable measured by minute. HHs who has proximity to the market center have a better chance to improve their income. Distance to market and food insecurity have a positive relationship [29]. Distance to nearest market expected to have a positive effect on the status of HH food insecurity.

Credit amount (CREDAMO)

It is a continuous variable. Amount of credit provided for the purpose of consumption or acquisition of agricultural inputs can help farmers to improve agricultural productivity. Furthermore, access to credit does initiate investment in different farm and non-farm activities and achieve food security [34]. Amount of credit is expected to have a negative effect on the status of HH food insecurity.

Receiving remittance (REMAMO)

It is a continuous variable. It is assumed that HHs that are accessible to financial support are able to buy necessary food and agricultural input [35]. Receiving remittance has negative relationship with the status of HH food insecurity.

Productive safety net program participation (PSNP)

It is a dummy variable for which value 1 is assigned was participate in the program, 0 otherwise. Farmer's participation in safety net program can protect asset depletion at the HH level and create communal assets at the community level. HHs who participates in the safety net program are obtaining food and cash aid frequently as compared to other groups. Productive safety net program participation was expected to have negative effect on the status of HH food insecurity.

Access to climatic information (CLMATE)

It is a dummy variable 1 HH who have access to climatic information, 0 otherwise. Farmers who had access to climatic information had a better intensity towards embracing food security. Information on source of drought-tolerant crop varieties, methods of soil conservation and use of irrigation can support HH food security level [36]. It has a negative effect on the status of HH food insecurity.

Size of cultivated land (CULLAND)

It is a continuous variable measured in a hectare. The possibility of harvesting higher yield directly related with size of cultivated land [29, 37]. It has a negative effect on the status of HH food insecurity.

Access to irrigation (IRRIGA)

It is a dummy variable (receiving support were code with a numeric value 1 and 0 if otherwise). Irrigation reduces the risk of crop failure and the increment in

Table 2 Relationship between discrete variables and HH food security status ($N = 200$; $FS = 72$; $FIS = 128$)

Variable	Categories	FS (%)	FIS (%)	χ^2
Agro-ecology	Lowland	42	44	0.0402
	Midland	48	46	
Soil and water conservation	No	26	83	64.68
	Yes	74	17	
Sex of HH	Male	56	66	2.083
	Female	44	34	
Agricultural extension	No	33	10	14.004***
	Yes	67	90	
Access to irrigation	No	80	51	18.557***
	Yes	20	49	
Provision of drought-resistant seed	No	84	30	58.66***
	Yes	26	70	
Productive safety net program participation	No	64	60	0.3704
	Yes	36	40	
Chemical fertilizer	No	84	30	25.930***
	Yes	26	70	
Climatic Information	No	75	25	48.625***
	Yes	25	75	

*** Significant at 1% χ^2 chi-square

yields can be substantial if properly managed thus it can ensure food security for farming HHs [30]. It has expected to have a negative effect on HH food insecurity.

Access to extension service (EXN)

It is a dummy variable assigned the value label 1 for HHs were access to adequate agricultural extension service

and 0 otherwise. Farmers who got support from extension agents are likely to improve their knowledge of using and managing their inputs very well as compared to farmers who don't get the service. This can probably improve their productivity and able them to tackle challenges which can minimize the probability of being food insecure [38]. Access to extension service has negative effect on status of HH food insecurity.

Table 3 Relationship between continuous variables with HH food security status ($N = 200$; $FS = 72$; $FIS = 128$)

Variable	Food Security status				Total Mean	T value
	FIS		FS			
	Mean	SD	Mean	SD		
Age of the HH	39.67	6.98	48.68	6.93	42.92	8.76***
Education status of HH head	2	1.91	6	3.76	4	13.707***
Family size	8	1.98	6	1.97	7	-4***
Number of oxen	0.234	0.46	1.375	0.72	0.625	13.63***
Cultivated land size in Ha	0.4	0.34	0.7	0.46	0.515	4.975***
Tropical livestock unit (TLU)	3.16	3.09	4.29	3.38	3.57	2.38**
Distance to the market	86	49	47	46	72	-5.493***
Credit amount	398	1062	2142	2789	1026	6.31***
Remittance received	369	1209	2499	3528	1136	6.22***
Income from off-farm activities (ETB)	1457	2370	2799	3044	1737	4.27***

*** Significant at 1%

** Significant at 5%

SD standard deviation, HH household, ETB Ethiopian birr

Off-farm activities and non-farm activity (OFFANO)

It is a continuous variable measured in ETB. HH head who engages in different means of income generation earn more income and has great chances of being food secure [28]. It is expected to have a negative effect between off-farm activities and non-farm activity and status of HH food insecurity.

Results

Household food insecurity status

Table 1 described about HHs' food security status of the study area. Among the total 200 HHs, following the recommended levels of food insecurity calculation, we categorized the HHs in to two groups (Food secure; Food insecure). The study indicated that 128 (64%) of the total HHs were food insecure. These HHs daily consumption level is below 2100 kcal. Average consumed kilocalories of the respondent HHs was 1966.82 kilocalorie per adult equivalency (S.D=893.05) which was below the national recommended kilocalories (2100) and minimum and maximum kilocalories of sample HHs are 432.86 and 5271, respectively.

Relationship between discrete variables and food insecurity status

Relationship between discrete variables and food insecurity status is presented in Table 2. Different discrete

variables were tested for the present of significance relationship with HH's food insecurity status. The proportion of female-headed HHs was higher in both categories (44; 34%). Based on the result of the study, agricultural extension, access to irrigation, adoption of drought-resistance seed, application of chemical fertilizer and availability of climate information showed significant relationship ($P \leq 0.01$) with the food insecurity status of the HH. The study also indicated that food secure HHs were involving less (17%) in soil and water conservation works as compared to food insecure (74%). The proportion of male-headed and female-headed food insecure HHs was 56 and 44%.

Relationship between continuous variables and HH food insecurity

Table 3 presents the relationship between continuous variables and HH food insecurity. All of the studied continuous variables showed significant relationship ($P \leq 0.05$; $P \leq 0.01$) with HH food insecurity. The mean age of food secure (48.68) HH is higher as compared to food insecure groups (39.67). A vast variation in the number of oxen, the number of livestock respondents own and the size of land cultivated by the two groups was

Table 4 Marginal effects after binary logit model output (N= 200)

Variables	Marginal effect (dy/dx)	SE	Z	P value
AGRECO	- 0.3380	0.1697	- 1.99	0.046**
SEXHH	0.4229	0.1569	2.69	0.007***
AHH	- 0.02216	0.01219	- 1.82	0.069*
EDUHH	- 0.09170	0.0424	- 2.16	0.031**
FSHH	0.00669	0.04237	0.16	0.874
TNO	- 0.46254	0.1636	- 2.83	0.005***
TLU	0.02,469	0.03,045	0.81	0.417
UCF	0.02119	0.0929	0.23	0.820
DRRESEED	- 0.14274	0.2199	- 0.65	0.516
SWC	- 0.35,550	0.15,555	- 2.29	0.022**
DISTMKT	0.001625	0.00,202	0.80	0.421
CREDAMO	- 0.000135	0.00,008	- 1.66	0.097*
REMO	- 0.000114	0.00006	- 1.85	0.064*
PSNP	0.16,150	0.17742	0.91	0.363
CLMATE	- 0.0700048	0.19035	- 0.37	0.713
CULLAND	- 0.50,902	0.20,214	- 2.52	0.012**
IRRIGA	0.2,370,844	0.17975	1.32	0.187
EXN	0.154,161	0.20,357	0.76	0.449
OFFANO	8.65e-06	0.00004	0.24	0.813
Number of observation	200	Pseudo R2	0.7286	
LR chi2(19)	190.44	Log likelihood	- 35.464524	
Prob > chi2	0.0000			

***, **, * significant at 1, 5 and 10% probability level, respectively; SE represents Standard Error

Table 5 Rural HHs coping strategies index (N = 200)

Local coping strategies	CSI	WMS	Rank
Rely on less preferred and cheap food	457	2.285	1
Participating in off-farm activity like wage employment	277	1.385	2
Borrow food from friends or relatives	206	1.03	3
Restrict food consumption of adults to feed children	201	1.005	4
Reduce the number of meals and limit the proportion size of a meal of household	200	1	5
Seasonal migration to other place	194	0.97	6
Receiving support from PSNP and other NGO in form of cash and kind	170	0.85	7

CSI represents coping strategy index; WMS represents weighted mean score

observed between the two groups. The average status of education for food secure HHs were 6 grade which was higher than the food insecure HHs i.e., 2nd grade. Food secure HHs were participated in different off-farm activities to generate income (2799 ETB) as compared to food insecure HHs (1457 ETB). The amount of credit and remittance provided for Food secure HHs were so much higher as compared to food insecure HHs. In addition, family size and distance to the market were also showed significant effects ($P \leq 0.01$) on the HH food insecurity and positive relationship with mean of HH food insecurity and significant at 1 percent significant level.

Marginal effect values for variables under study

The present study indicated that agro-ecology, sex of HH head, age of HH head, educational status of HH head, number of oxen owned, soil and water conservation practices, availability of credit and remittance and size of cultivated land were showed a significant relationship with level of food insecurity at $P \leq 0.05$; $P \leq 0.01$. Negative relationship was observed with all the significant variables except sex of HH head (Table 4).

Local coping strategies to food insecurity

Rank for different local coping strategies towards food insecurity is presented in Table 5. Relying on less preferred and cheap food was ranked first 457(2.285) among other local coping strategies followed by participating in off-farm activities 277(1.385), borrow food 206(1.03), and restrict food consumption 201(1.005).

Discussion

The ever-continuing hunger and undernourishment is the biggest challenge to numerous communities and HHs found in different part of Ethiopia. The severity of the situation is varied due to different determinant factors. Female and food insecure HHs' proportion in this study area is very high as compared to the national average i.e., 20.6% [39]. This difference might arise due to the implemented selection criteria. The selection criteria is based

on the frequency of drought occurrence, level of food insecurity and relative number of safety net program beneficiaries. This can boost the number of vulnerable groups which can get in to the selection process. Undertaking investigation on the basic determinant factors and local coping strategies can help to spot out concrete recommendation which further guide projects working food insecurity. Due to the escalating coverage of agricultural sectors to risks, the adoption of efficient strategies and policies to cope with risks has been done taken as primary agenda in different developing countries [40, 41]. Food security level is directly related to food availability and consumption level at HH level [42]. This study cites a base line to categorize food security level of HHs. Households who consume below the minimum requirement i.e., 2100 kilocalorie per day as food insecure, and those HHs who consume equivalent to and above the minimum requirement considered as food secure. Based on this cut-off or benchmark, about 64% of the respondents are food insecure. Average consumed kilocalories of the responding HHs i.e., 1966.82 kilocalorie per adult equivalency (S.D = 893.05) is below national recommended kilocalories [4] (Table 6).

Investigating the critical variables which are highly affected by food insecurity can be useful to bring sustainable change in relation to food security. In this study, discrete data such as agro-ecology, sex of respondent, soil and water conservation, are identified to have a significant effect ($P < 0.05$) on the HH food insecurity. This might be due to majority of the variables directly or indirectly affect productivity of cultivated land. Continuous variables such as age of HH heads, education status of HH heads, and cultivated land size in hectare, number of oxen, credit amount, and remittance received have also showed significant effect ($P \leq 0.05$) on HH food insecurity. Majority of agricultural inputs information can be accessed from different Medias, and farmer's information acquiring capacity can rely with their education level. Even if majority of the developing countries are still livestock dependent for different purposes such as

Table 6 Expected sign of the independent variable with the dependent variable

Variable acronyms	Independent variables	Measurement	Status of HHs food insecurity
AGRECO	Agro-ecology	It is dummy 0 was assigned for lowland, 1 was assigned for midland	-
SEXHH	Sex of HHs head	It is a dummy variable (i.e.1 if it is female and 0 otherwise)	+
AGEHH	Age of HHs head	Continuous measured with age	-
EDUHH	Education HHs head	Continuous measured with year of schooling	-
FSHH	Family of size HHs head	Continuous measured with adult equivalency	+
TNO	Number oxen	Continuous measured in number of oxen	-
TLU	Tropical livestock unit	Continuous measured with tropical livestock unit	-
UCF	Use of chemical fertilizer	It was a dummy variable taking the value of 1 if a farmer was being used fertilizer and 0 otherwise	-
DRRESEED	Drought-tolerant seeds	It is a dummy variable that takes a value of 1 if farmers used improved seeds and zero, otherwise	-
SWC	Soil and water conservation	It is dummy variable 1 if a HH is practicing soil and water conservation and 0 otherwise	-
DISTMKT	Distance to nearest market	It is a continuous variable measured minute	+
CREDAMO	Credit amount	Continuous variable measured in Birr	-
REMAMO	Receiving remittance amount	Continuous variable measured in Birr	-
PSNP	Productive safety net program	This is a dummy variable for which value 1 is assigned was participate in the program, 0 otherwise	-
CLMATE	Access to climatic information	It is dummy variable 1 HH who have access to climatic information, 0 otherwise	-
CULLAND	Size of cultivated land	Continuous measured with hectare	-
IRRIGA	Access to irrigation	It is dummy variable (receiving support were code with a numeric value 1 and 0 if otherwise)	-
EXN	Access to extension service	It was dummy variable assigned the value label 1 for HHs were access to adequate agricultural extension service and 0 otherwise	-
OFFANO	Off- and non-farm	Continuous measured in Birr	-

ploughing, source of fertilizer, source of fuel and source of food, among the livestock group, oxen has the significant importance in majority of the agricultural activities. Similarly, HH's oxen holding capacity have negative relationship with HH food insecurity status significance at less than 1% probability level. The probability of being food insecure decreases by 46.2 percent, as a number of oxen increases by one. The model output indicates that conformity with a study by [11, 32].

The present study indicates that HHs who lives in midland agro-ecology is less likely to be affected by food insecurity than those who live in the lowland. The marginal effect estimation indicates that all other things constant, the probability of being food insecure in the midland is decreased by 33.8%. This result is in line with studies done by [43]. The probability of female HH head being food insecure is increased by 42.3%. This might be due to male-headed HHs are likely to access education and participate more in different community works. This can make them more experienced in tackling food insecurity through accessing other income generation means and adoption of new agricultural technologies as compared to female groups. This result is in conformity with

the study done by [30, 31]. Age of HH head has a negative relationship with food insecure. This estimate indicated that food insecurity decreases with increase in age of HH head. The probability of being food insecure decreases by 2.21% as the age of the HH is increased by one year. The above finding is in line with [28]. Household heads level of education can let them to easily adopt different technologies to update the conventional farming system and improve agricultural productivity. This study indicates that one additional schooling year can minimize the probability of HH to be food insecure by 9.1% or, additional year of schooling reduces the likelihood of food insecurity by a probability of 0.092. This model output is in agreement with the finding of [9, 44]. All other things are constant, the probability of being food insecure for HHs who have not practiced soil and water conservation decreases by 35.5%. This model output is similar with the finding of [33]. Household's access to credit services can decrease the food insecurity incident by 0.0135% as credit amount increases by one Birr (ETB). This result is similar with [45]. The probability of being food insecurity is decreased by 0.0114% as HHs receives one birr increase in remittance. This implies that receiving remittance has

been helping HH heads to decrease their food insecurity level. The result is similar with [35] in rural northern hinter land of Pakistan. Similarly, all other things constant, the probability of being food insecurity decrease by 50.9% as the size of cultivated land amount increases by one hectare. This result is in line with [11] in Oromia region of Ethiopia.

Agricultural risks are troublesome to small-scale farmers in developing countries. The types and severity of the risks confronting farmers vary with the farming system and with the climate, policy, and institutional based setting [46]. Strategies that have been acquired through long years of farmers experience is relevant to deal with the existing challenges. Farmers, rural institutions and lenders encompass, over generations, develop ways of reducing and coping with risk. For all, experience plays a substantial role in decision-making process of averting and minimizing risks in farming activities. Farmers' participation in crop insurance is increased with experience [47]. Farmers who rely on traditional risk-coping strategies have been facing fundamental problem, but nearly all kinds of farmers affect by production and price risks simultaneously [48]. Traditional risk management arrangements frequently fail to provide an adequate safety net for the poor, and limited in its ability to manage disastrous risks. Similarly, private side role in insuring farmers and rural communities against agricultural risks has also been insignificant [49]. In developing countries, agricultural risks are treated majorly by food aid from GO and NGOs after the occurrence. Massive food aid became ineffective instrument in responding to such problems, and the percentage of food-insecure HHs never shows a decline [43]. Agricultural risks are still managed with coping strategies rather than risk-reducing strategies. Most farmers in Ethiopia are producing just for subsistence purpose. Though risk-reducing strategies are effective in addressing many production and market risks, they are costly even for average income generating farmers. It might force them to abandon their most profitable alternatives. In this study, eleven different coping strategies are very prominent among all available local coping strategies towards tackling food insecurity. Among them, relying on less preferred and less expensive food ranks first (2.285). Frequent use and farmer's preference towards this strategy might be primarily linked with higher foodstuffs price (inflation of food price). The second ranked strategy is participating in off-farm activities (1.385). Information collected from FGD and KII indicates that the major off-farm activity in which HHs has been generating income is through day labor and land rental. The third (1.03) strategy is borrowing food from friends or relatives. This shows social relationship of the communities is very strong even in the worst times.

However, FGD participants have witnessed that lending food from the collected small crop yield to food insecure HHs have been making the situation more severe because probability of repaying their debt in the coming year is very low. This can also be additional factor that can increase the number of food insecure HHs. Restricting food consumption as coping strategy has been directly affecting children who stay at home. Food insecure adults have the chance to identify food source while they are working in different off-farm activities. If the situation is so much worse, HHs have been forced to migrate to other places to save their lives. Though Ethiopia has adopted a food security strategy in 1996, due to a reduction in the amount of annual rainfall, some regions of the country are still emergency relief assistance dependent. More than half (around 3.7 million people) of Ethiopian Somali national region population were aid by WFP's emergency relief assistance due to rainfall reduction in 2016 [50]. Technology-based risk-coping strategies such as designing a suitable weather index by considering the different climatic variables can help to forecast spatial pattern of crop loss in an area [51]. It is also very crucial to develop and implementing public policy which give emphasis to agricultural risk management for food security [52]. Intervention implementation plans in such area by GO and NGO have been done poorly. It is mostly become active when the situation is become worse and when it reaches to the status of hunger. Due to the above reasons, HHs trust on those intervening organization is very weak. In addition, very fragile risk-sharing arrangements for small-scale farmers in developing countries increase the burden of risk for the individual farmer and destabilize farm incomes [46].

The prevalence of risk in agriculture is not new and farmers, rural institutions and lenders over generations have been developing ways of reducing and coping with risk. Despite these developments, agricultural insurance remains far too small to meet the risk management needs of most farmers and rural people in developing countries. This is basically due to crop insurance demands farmers' experience, subsidies and wide set of contracts which help them to make decision [53]. Moreover, [47] indicate that entry and exit decisions remain crucial to enhance crop insurance. Policymakers should take this dimension into consideration to improve the efficacy of planned interventions giving due emphasis to role of information, experience and farm size. Traditional risk management mechanisms are not sufficient to shield farmers from frequently observed food insecurity. Alternatives that are supported by technology and experience can be more efficient coping up strategies in developing countries.

Conclusion

The study concluded that 64% of the participated HHs in this study was food insecure. All measured continuous variables showed a significant relationship with status of food security. The level of food security was also determined by availability of agricultural extension, access to irrigation, provision of drought-resistant seed, access to chemical fertilizer and climate information. Age of HH head, sex of HH head, education status of HH head, size of cultivated land, number of oxen, soil and water conservation, access to remittance and credit amount showed a significant relationship with food insecurity. Among the significant relationship, negative relationship was observed between food insecurity and majority of tested variables (i.e., agro-ecology, education status, number of oxen owned, soil and water conservation, access to credit and remittance and size of cultivated land) except being male HH heads. Various local food insecurity coping strategies had been used by HHs in the study area but the first three ranks were relying on less preferred and cheap food, participating in off-farm activity and borrowing food from friends or relatives, respectively. The study recommends that intervention that provides support to farms in the area of enhancing agricultural productivity through agricultural extension; increase access to irrigation, improved seed, fertilizer and chemical fertilizer can minimize the food insecurity level of HHs. Furthermore, special attention should also be given to female and uneducated HHs, particularly in the lowland agro-ecology. Efforts to increase the size of cultivated land per head, number of oxen and livestock owned should be invested. Governments and non-governmental organizations interventions should focus on improving access to agricultural technologies basically on improved seed provision, soil and water conservation, irrigation technology rather than sticking to provision of remittance and credit.

Abbreviations

CSI: Coping Strategy Index; ETB: Ethiopian Birr; FGD: Focus Group Discussion; GO: Government; GTP: Growth and Transformation Plan; Kcal: Kilocalorie; HH: Household; KI: Key Informant Interview; NGO: Non-Governmental Organization; PA: Peasant Association; PIF: Policy and Investment Framework; PRA: Participatory Rural Appraisal; SD: Standard Deviation; SE: Standard Error; TLU: Tropical Livestock Unit; WFP: World Food Programme; WMS: Weighted Mean Score.

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Author contributions

MM conducted the field research, analyzed the data, and drafted the manuscript. MM, MT and MA designed the research, interpreted the results, and were involved in the manuscript writing. All authors revised the manuscript and read and approved the final version.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

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Competing interests

The authors declare that they have no competing interests.

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