Determinants of Rural Households' Vulnerability to Food Insecurity in Gamo Gofa Zone, Southern Ethiopia

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Research

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Abstract

The aim of this study was to measure the level and determinants of rural households' vulnerability to food insecurity using a sample of 574 households and feasible generalized least square method. Results showed that the mean level of food insecurity at high land, low land and middle land areas are 73.12, 77.11 and 52.24 percent respectively. But mean level of vulnerability to food insecurity at high land, low land and middle land areas are 76.87, 84.32 and 55.62 percent respectively. The overall level of food insecurity and vulnerability to food insecurity in the study area are 68.31 and 73.34 perecent respectively. Thus, vulnerability to food insecurity is more wide spread in the study areas particularly in moisture stress low land area. Logistic regression showed that age of household, family size, off farm income, safety net programs, distance from health, death of household members and death of animals significantly increase rural households' vulnerability to food insecurity. But, farm income, irrigation use and credit uses significantly decrease rural households' vulnerability to food insecurity. Hence, government may help rural households to gather more resources and reduce vulnerability to food insecurity via better access to credit, infrastructure, irrigation uses and population control.

Keywords: Vulnerability; Food insecurity; Feasible Generalized Least Square; Logistic Regression; Ethiopia

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1. INTRODUCTION

Now a days, we are living in the world where about 842 million people are food insecure, and the majority of food insecure people live in developing countries in general and Sub Saharan African countries in particular, FAO (2013). Sub-Saharan Africa is the area in the world that is mostly hit by food insecurity and is not in the right track to reduce vulnerability to food insecurity, GAO (2008) and Sub Saharan Africa is the lowest in terms of general food insecurity index in the world showing the lesser degree of resilience of the region to food insecurity, EIU (2014). Food insecurity is one of the development challenges of developing countries in general and African countries in particular, FAO (2010). About one billion people are estimated to be undernourished where 98% of these people are living in developing countries. Sub Saharan Africa has the highest prevalence of under-nourishment among developing regions. For instance, the percentages of under nourished people were 11.3, 13.5 and 24.8 in the world, developing countries and Sub Saharan Africa respectively in 2014, World Bank (2013).

As part of SSA, Ethiopia faces daunting poverty and food insecurity challenges that have been worsening overtime. The percentage of undernourished people in Ethiopia was 35 percent in 2014, and Ethiopia is ranked first in terms of the number of people in state of under nourishment with 32.1 million under nourished people in Africa, FAO (2015). The high-level food insecurity in Ethiopia is mainly caused by the poor performance of the agricultural sector and this poor performance of agricultural sector in Ethiopia attributes to both policy and non-policy factors, Temesgen et'al (2016).

Food insecurity in Southern Ethiopia has remained a multifaceted and complex problem in which lack of access, availability, quality and stability of food still play an important role in influencing the food security status of the population and according to recent estimate, 24% of the total households in Southern Ethiopia are found to be below poverty line with poverty, CSA (2014) and near to 59 percent of the households in Southern Ethiopia is also found to be food insecure, Melkamu (2011). Southern Region which is one of the nine Regions in Ethiopia has a population growth rate of 3.6 percent which is far above the national average of 2.5 percent and this implies that population may have exceeded the carrying capacity of the already fragile environment production capacity, Melkamu (2011).

Food security is a broader concept and it is more than food production and accessibility. In reality it comprises of four pillars namely food availability, food accessibility, food utilization and stability of food supply, Gross et al (1999) and Babatunde (2008). In recent years, there has been increasing awareness that the analysis of food insecurity should be carried out in dynamic context. It is essential not only to just look at the current incidence of food insecurity but also individuals, households or communities are more at risk of suffering in near future, Thabane (2013). This implies that, people may move in and out of food insecurity with the passage of time. Being food insecure today doesn't necessarily imply high probability of being so in future because there may be an improvement in food situation if looking beyond the short run, Babatunde (2008). Hence, there is a need to move from a mere analysis of current incidence of food insecurity to a forward-looking future incidence of food insecurity to capture the dynamic and multidimensional concept of food security. The main analytical concept that has been developed and appeared in food security literature to address the issue of future incidence of food insecurity is said to be vulnerability analysis, Babatunde (2008), Adger (2006) and Thabane (2013). Vulnerability can be defined as the diminished capacity of an individual to anticipate and resist the impact of natural or manmade hazard, DFID (2008).

Survey of literature on food insecurity and vulnerability shows that even if attention is given to the study of food insecurity in developing countries, there are relatively fewer empirical studies in the literature on vulnerability of households to food insecurity. Yet, reducing vulnerability is a pre-requisite for achieving global and national food security targets, Lovendal and Knowles (2005). Food insecurity is a persistent problem in Ethiopia attracting the attention of the government and different organizations. Even if there are a few studies in Ethiopia concerning the vulnerability food insecurity issue, most of these previous studies such as Mesfin (2011), Bogale (2012), Getu (2012) and Temegen et al (2015) concentrated in the Northern parts of the country, and the attention of most these researchers were towards food insecurity issue. Therefore, this study is designed to measure the level of vulnerability to food insecurity and examine the determinants of vulnerability to food insecurity in southern Ethiopia. Specifically, this study aimed:

a. To measure the extent of food insecurity in the study areas using household kilocalorie intake method

b. To measure the level of vulnerability to food insecurity in Southern Ethiopia using Chaudhri method and compare the charactertics of vulnerable and non-vulnerable sample households
c. To examine the determinants of the vulnerability of households to food insecurity using maximum likelihood estimation.

2.BASIC CONCEPTS, THEORIES AND EMPIRICS

2.1 Basic Concepts of Food Security

Food security was introduced for the first time in the literature following the world food conference held in 1974 due to the then food crises and major famines. Since then, researchers defined food security differently for their own purpose, Tsegaye (2009). Food security was defined as the availability of adequate food at global and national level by UN (1970). This macro level definition of food security only refers to the supply sides of food security by disregarding the demand side of food security. That means, it disregards the other important dimensions of food security like food access, utilization and stability and it considers only food availability at national and global level. But, food availability at global and national may not necessarily imply food security at household level (UNDP, 1992). This definition of food security led to the development of the food availability decline theory of food security and researchers tried to examine the determinants of food availability at global and national level.

However, the food access dimension of food security has got a wider attention since 1980 and the unit of analysis of food security also has shifted from global and national level to household level of food security. This shift in paradigm from supply side to demand side of food security came up with new concept and definition of food security, Debebe et'al (1995). Food security is defined as access by all people at all times to enough food for an active and health life (WB, 1986). According to this definition, food security refers to a situation in which individuals have physical and economic access to the food they need. A household is considered to be food insecure if its consumption falls below the minimum daily recommended caloric intake for an individual to be active and healthy. Still this definition of food security does not include one dimension of food security, food utilization. This definition of food security also led to the development of the food entitlement decline theory of food security which states that food security depends on household's

entitlement to food. There are four sources of household's food entitlement namely; own production, own labor, trade and transfer.

Finally, a definition of food security which contains both the demand and supply sides and all the four dimensions of food security was given by FAO (1996). Accordingly, food security is defined as the situation when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). This shows that food security is a broader concept and it is more than food production and food access. It consists of four pillar dimensions namely; food availability, food accessibility, food utilization and stability of food supply. Food availability refers to the physical presence of food at household level whether from own production or through markets. Food access refers to the ability of household to obtain appropriate diet and is in particular linked to resources at household level. Food utilization, which is related with biological concept, refers to the individual level of food security and it is the ability of human body to convert food into energy. Stability of food supply refers to the current and future food status at different point in time. The term all times refers to stability dimension in the food security definition.

Food security has both spatial and temporal dimensions. The spatial dimension of food security shows the level of analysis and food security can be analyzed at global, national, sub-national, village, household or individual level. But, in most empirical studies on food security, household is commonly used as unit of analysis. The time dimension of food security refers to the time periods over which the food security is considered. Accordingly, food security can be of transitory or permanent food security. Transitory food insecurity refers to a short term or transitory decline in household access to enough food due to domestic violence, occurrence of drought, outbreak of crops diseases and the like. Permanent or chronic food insecurity refers to long term or persistent inability to meet the minimum food consumption requirements which may occur due to lack of access to productive assets and climate change, Debebe et'al (1995).

Vulnerability to food insecurity refers to people's propensity to fall or stay below a pre-determined food security line. The food security line could be calorie based or it could include all basic needs, Zeller (2006). Since people move in and out of food insecurity, vulnerability is an ex ante probability of falling or remaining below the set of thresholds of welfare while food insecurity

refers to the current or ex post measure relative to threshold level. Because vulnerability is linked to uncertainty of events, everyone is vulnerable to food insecurity, but some more so than others. Being food insecure today does not necessarily indicate vulnerability, because the food situation could improve if looking beyond the very short run. Chronically food insecure people are living below the food security line today. Potentially food insecure people are living on the edge. Although they are not food insecure today, they face a high probability of becoming food insecure, Babatunde et al (2008).

2.2 Theories of Food Security

There are various theories about the determinants of the four dimensions of food security. However, these theories are categorized in to three and they include, the political economy theory of food security, the food availability decline theory of food security and the food entitlement decline theory of food security. The food availability decline theory explains the supply side factors while the food entitlement theory of explains the demand side determinants of food security. Besides, the political economy theory of food security blames government policies or the relationship between the society and government as sources of food insecurity.

The first theory of food security is the food availability decline theory which focuses only on the supply side of food security. According to this theory, food insecurity is caused by lack of productive assets to produces goods and services and to purchase food. This approach considers food insecurity as shortage of food supplies per capita which can be caused by drought, floods, crop failures, population growth and other demographic factors, Diana (2007). Therefore, any factors which disrupts food production such as drought, flood, war, population growth and other demographic factors cause food insecurity. Nevertheless, this theory is criticized for focusing on the supply side constraint to food insecurity.

Though the food availability theory blames population growth as a cause for food insecurity in agrarian economy, there are two competing theories regarding the relationship between population growth and food availability. The first one argues that unless population increase is checked, food production increase cannot keep pace with it, Malthus (1798). According to him, population growth causes food shortage and thereby, food insecurity. Malthusian theory of population

criticized on the ground that it ignores the role of technological improvement which increases the productivities of scarce resources and leads to higher outputs. Boserup (1965) considers population growth as sources of invention and innovation of new technologies that expands agricultural production and thereby reducing vulnerability to food insecurity. She argues that the positive effect of population on food supply can be realized by making better investments in infrastructure like water supply, irrigation, energy, transport and improved production technologies.

The second theory of food security is the food entitlement decline theory of food security which focuses on the demand side of food security as the causes for food insecurity. Sen A. (1981), shifted the focus of attention from supply side constraint to demand side constraint. As opposed to food availability decline theory of food security, the food entitlement theory of food security emphasizes access to food, or people's relationship to food, rather than availability of food (Devereux, 2006). Sen (1981) discovered that food insecurity affects people who cannot access adequate food because of exchange failures irrespective of food availability at national or global levels. The main argument of this theory is that the presence or availability of food in the economy doesn't necessarily imply consumption and hence food insecurity may occur without any decline in food availability, Getachew (1995).

The food entitlement decline theory of food security has some merits over the food availability decline theory of food security in a number of ways. First, it suggests that demand side matters as opposed to supply side. Second, it allows vulnerable group to be identified at household level. Finally, it suggests more appropriate policy intervention than food availability decline theory of food security. But, the food entitlement decline theory of food security is not free from criticism. It is criticized on the ground that some people with ample entitlement may prefer to go food insecure at certain times rather than selling their assets fearing of future crisis, Ali (2008).

The political economy theory of food insecurity states that food insecurity is not only caused by lack of food production or food access, but due to political powerlessness. According to this theory, rather than focusing only on food availability and food access as a means of coming out of food insecurity problem, due attention should be given to state reconstruction, good governance and accountability. That means, the relationship between the society and the government actors is

important to ensure food security in addition to managing the demand and supply of food. So, according to this theory, food insecurity may result from wrong government policies, domestic violence, government failure to intervene and conflicts over limited natural resources, Arega (2013).

2.3 Measurement of Vulnerability to Food Insecurity

There is no established consensus in the literature regarding the most appropriate approach analysis of vulnerability and most the analysis of vulnerability focuses on poverty rather than on food insecurity, Scaramozzino (2006). Basically, there are two main approaches to vulnerability measurement namely; outcome approach and utility approach. Outcome approach measures vulnerability in terms of expected poverty, Chaudhuri (2001), Chaudhuri, Jalan and Suryhadi (2009). The utility-based approach measures vulnerability as the difference between utility that household would derive from the consumption of a particular bundle with certainty and the expected utility of consumption, Ligon (2003) and Schecter (2004).The outcome approach to vulnerability can help provide a quantitative measure of incidence of vulnerability, which is useful in placing households with respect to the reference threshold, Kamanou and Morduch (2002). Though there is no universally accepted approach of measuring vulnerability to food insecurity, this study used outcome approach of vulnerability measurement by adopting ‘’Vulnerability as Expected Poverty’’ method to analyze the determinants of vulnerability to food insecurity.

While measuring vulnerability to food insecurity, first we have to model food consumption measured in kilocalorie on the household’s observable characteristics. This assumption allows us to estimate vulnerability using cross-sectional data from a single point in time, thereby limiting data requirements. The analytical methodology is similar with Christiansen and Boisvert (2000) and Bogale (2012) in that food consumption is approximated by kilocalorie consumption. In order to project future consumption, we first estimate a model of calorie consumption whereby the latter is a function of a number of household characteristics. Since the residuals that will be generated by this estimation may correlate to each other and exhibit different variances, the model is unable to capture all the systematic variability of the dependent variable, consumption in this case. To address this, we take a second step which involves estimating weighted least squares, a model of the residuals that explains their variability. This second step gives us estimates of the residual variance. Lastly, we use the estimate of variance of the residuals to calculate the probabilities that

kilocalorie consumption, which we assume normally distributed, may be lower than an acceptable threshold, Chaudhuri (2000) and Mesfin (2014).

3. MATERIALS AND METHODS

3.1 Description of the Study Areas

According to 2007 CSA data, the population of the Southern Nations Nationalities, Peoples Region State is estimated at 15.3 million and this accounts for approximately 20% of the total population of the country. The Region has 15 Zones that consist of a total of 125 Districts, 3561 rural kebeles, 90 towns. Hawasa is the capital city of the region. Gamo Gofa Zone is one of the 15 zones in Southern Nations Nationalities People's Region State. There are five indigenous ethnic groups in this Zone with distinct languages and cultural base. The Zone has a total area of 12,581.4 square kilometers and administratively consists of 15 rural Districts namely; Arba Minch Zuria, Mirab-Abaya, Boreda, Chencha, Dita, Kucha, Daramlo, Bonke, Kemba, Zala, Ubadebretsehay, Oyida, Demba Gofa, Geze Gofa and Melakoza. Arba Minch town is the administrative and trading center of Gamo Gofa Zone, located at 505 km from Addis Ababa and 275 km south west of Hawassa. The general elevation of the Gamo Gofa zone ranges from 680 to 4207 meters above sea level. The total population of the Gamo Gofa zone is estimated about 1,593,104 with a population density of 144.68 inhabitants per kilometer square and 157,446 or 10% are urban inhabitants.

3.2 Data Sources and Sampling Techniques

To achieve the stated objectives, this study mainly depends on the primary sources of data. Primary data were collected via structured questionnaires which are managed by enumerators from a sample of 574 rural households. Besides, focus group discussion were held with key informants from each sample kebele and some District officials so as to back the data obtained via questionnaires. To complement our primary data sources, some general information about the Southern Nations Nationalities and People Regional State were gathered from secondary sources which are published and unpublished documents.

In Gamo Gofa Zone, there are 15 Districts and three sample Districts were purposively selected for this study in the first stage, and each of them are from different ecological zones. The three sample Districts are Chencha District from high land, Kamba District from low land and Denba

Gofa District from middle land areas. There are 34, 38 and 45 rural kebeles in Denba Gofa, Kamba and Chencha District respectively. In the second stage, depending on the distribution of kebeles in each sample District, four rural kebeles are from Chencha District, three rural kebeles are from Denba Gofa District and four rural kebeles from Kamba District were randomly selected for this study. There are also 18274, 29832 and 20340 total households in Denba Gofa, Kamba and Chencha respectively as indicated in CSA (2007). Thus, proportionately 160, 236 and 178 sample households were selected from Demba Gofa, Kamba and Chencha District respectively. So, primary data were collected from 11 sample rural kebeles and a total of 574 sample rural households in the study areas using systematic random sampling (SRS) technique.

3.3 Models of Food in security and Vulnerability Analysis

The vulnerability model we are going to use in the present study follows Chaudhuri's suggestion and assume that all the cross-sectional variability of our crucial variable – dietary energy consumption, measured through kilocalorie – depends on the household's observable characteristics. In modeling vulnerability to food insecurity, first we have to model food consumption measured in kilocalorie on the household's observable characteristics. This assumption allows us to estimate vulnerability using cross-sectional data from a single point in time, thereby limiting data requirements. The analytical methodology is similar with Christiansen and Boisvert (2000) in that food consumption is approximated by kilocalorie consumption.

In order to project future consumption, we first estimate a model of calorie consumption whereby the latter is a function of a number of household characteristics. Since the residuals that will be generated by this estimation may correlate to each other and exhibit different variances, the model is unable to capture all the systematic variability of the dependent variable. To address this, we take a second step which involves the estimation of weighted least square model of the residuals that explains their variability. This second step gives us estimates of the residual variance. Lastly, we use the estimate of variance of the residuals to calculate the probabilities that kilocalorie consumption, which we assume normally distributed, may be lower than an acceptable threshold.

Suppose that the log of per capita kilocalorie consumption of each household is a function of a vector of characteristics such as household size, level of education, location, etc. So as to determine the vulnerability index for each sample household, the Chauduri (2000) approach of measuring

vulnerability index is used. Suppose that the stochastic process for generating per capita consumption expenditure Ci for the ith household is specified as

$$lnC_i = \alpha + X_i'\beta + u_i \quad (1)$$

Where C_i percapita kilocalorie consumption for the i^{th} household at a point of time while Xi represents a bundle of observable determinants of percapita kilocalorie consumption. The parameter β is a vector of coefficients of household characteristics to be estimated and u_i is a mean-zero disturbance term that captures idiosyncratic shocks that contribute to different percapita kilocalorie consumption levels. The consumption model in equation # (1) assumes that the disturbance terms has mean zero, but varies across households. Therefore, the variance of the disturbance term violates the OLS assumption of constant variance and it varies with the determinants of percapita kilocalorie consumption as follows.

$$\hat{\delta}_i^2 = X_i'\gamma + \alpha + v_i \quad (2)$$

To account for heteroscedasticity in equation # 1 and get efficient estimates of β, the researcher used a three-stage feasible generalized least square method in estimating equation #1 and equation #2. First, the researcher estimated equation #1 using ordinary least square method of estimation to obtain the estimated residual, $\hat{u}_i$. From the estimated residual, the researcher determined the square residual, $\hat{\delta}_i^2$ and used as outcome variable in equation # 2. In the second step, the variance obtained in the first step is regressed on the household socioeconomic characteristics and other charactertics as can be seen from equation # 2 using ordinary least square estimation. From this second estimation, the variance of the error term is estimated and used to avoid the problem of heteroscedasticity from equation # 2 as follow.

$$\frac{\delta_i^2}{\delta} = (\frac{X_i'}{\delta})\gamma + \alpha(\frac{1}{\delta}) + \frac{v_i}{\delta}$$

$$\delta_i^{*2} = X_i^*\gamma + \alpha * + v_i * \quad (3)$$

The variance of equation #3 is homoscedastic and the estimated coefficients are now efficient and the variance obtained from equation # 3 is used to correct equation # 1 for heteroscedasticity and can be specify as follows.

$$lnC_i\left(\frac{1}{\delta*}\right) = \alpha\left(\frac{1}{\delta*}\right) + \beta'\left(\frac{X}{\delta*}\right) + \frac{u_i}{\delta*}$$

$$lnC_i^* = \alpha^* + X_i^*\beta + u_i^* \quad (4)$$

Equation #4 is estimated using ordinary least square estimation and this gives us efficient estimates of the parameter β. We then, generated the expected percapita kilocalorie consumption for each household by using equation#4. The expected percapita kilocalorie consumption thus generated are compared to the constructed minimum kilocalorie of 2200 per day per adult equivalent. Households with predicted percapita kilocalorie consumption of less than 2200 kilocalorie are classified as food in secured and those that are greater or equal to 2200 kilocalorie are classified as food secured. Then, the sample households divided in to two, food secured and food in secured households. A dummy dependent variable is generated by giving 1 for food in secured households and 0 for food secured households in the study area. Next, logistic regression model is estimated to generate vulnerability as expected probability of being food in secured in the future. This model gives us also the determinants of food insecurity in the study area.

$$ln\left(\frac{p(Y_i=1)}{p(Y_i=0)}\right) = ln\left(\frac{\text{Pr (Food Insecured}}{\text{Pr (Food Secured}}\right) = X'\beta \quad (5)$$

The ultimate outcome of this calculation is a set of estimates V_i which measures the probability that each household is falling below the minimum energy requirement in the future. Each estimate takes values in the interval, [0, 1]. When $V_i = 0$, household will consume in the future with certainty at least the minimum amount of calories which is prescribed by the threshold and when $V_i = 1$, household will consume less calories in the future than the one which is prescribed by the threshold. In all intermediate cases, when $0 < V_i < 1$, no particular outcome is anticipated ex ante. Since we can attach an index V_i to all households, the question arises which households should be considered vulnerable in between the two extremes. This is particularly important for the design on any mitigating interventions and associated policy formulation. It makes sense to consider households that have an estimated vulnerability close or equal to unity as vulnerable and those with a vulnerability index close or equal to zero as non-vulnerable.

Finally, the researcher estimated the determinants of vulnerability by giving 1 for households with $V_i \geq 0.5$ and 0 for households with $V_i < 0.5$ using logistic regression model. Since the dependent variable is dichotomous, this model can be estimated using maximum likelihood estimation and can be specified as follow.

$$V = \alpha + X_i'\beta + V_i \quad (6)$$

$$Pr\ (V = 1) = \ G\ (Zi) \quad (7)$$

Where G is a function taking on values strictly between 0 and 1. That means, 0≤ G (Zi) ≤1, for all real numbers Zi. This ensures that the predicted probability (Pi) strictly lies between 0 and 1. For Logit model the above model can also be specified as follow.

$$ln(\frac{Pr(V=1)}{Pr\ (V=0)}) = Li = Zi \quad (8)$$

Finally, an empirical model for the determinants of rural household vulnerability to food insecurity can be specified as follow:

$$Li = \ \beta 0 + \beta 1AGE + \beta 2FEMALE + \beta 3EDUC + \beta 4LS + \beta 5FS + \beta 6ROAD + \beta 7IRR + \beta 8FY + \beta 9DMRT + \beta 10CREDIT + \beta 11OFI + \beta 12SNP + \beta 13ADE + \beta 14EQUIB + \beta 15URH + \beta 16DSTH + \beta 17AD + \beta 18Chencha + \beta 19Demba\_Gofa + Ui \quad (9)$$

Where, Li is the natural log of odds ratio, AGE is the age of household head, FEMALE is the sex of household head, EDUC is the years of schooling of household head, LS is the land size of household, FS is family size, ROAD is the distance from all season road, IRR is the use of irrigation, DMRT is distance from market, CREDIT is access to credit, OFI is off farm income, SNP is safety net program participation, ADE is adult equivalent, EQUIB is participation in equib, URH is urban house ownership, DSTH is distance from health center, AD is animal death, Chencha and Denba Gofa location dummies.

Regarding the expected sign of the parameters, urban house ownership, off farm income, years of schooling, land size, participation in irrigation, participation in equib, farm income, participation in safety net program and uses of credit access are expected to reduce households vulnerability to food insecurity while distance from all season road, family size, distance from market, distance from health center, animal death and the dummy for gender are expected to increases the vulnerability of rural households to food insecurity in the study areas.

4. RESULTS AND DISCUSSION

4.1 Descriptive Data Analysis and Mean difference Tests

Data from a sample of 574 rural households were collected and analyzed using both descriptive and econometric methods so as to attain the specific objectives of this study. As indicated in Table 1, mean kilocalorie per adult equivalent per day at Chencha, Kamba and Denba Gofa Districts are 1911.6, 1679.2 and 2554.4 respectively. This indicates that the mean kilocalorie per adult equivalent per day at Denba Gofa District is higher than the other two sample Districts. Similarly, the mean consumption per adult equivalent per month in Ethiopian Birr at Denba Gofa District (699.1) is higher than the mean consumption per adult equivalent per month at Chencha District (537.5) and at Kamba District (487.126). As evidenced from Table 1, the mean monthly income from off farm activities in Ethiopian Birr at Chencha District (1472.6) is higher than the mean monthly income from off farm activities Kamba District (200.4) and Denba Gofa District (498.8). This is due to the fact that, rural households at Chencha District are mainly engaged in weaving activities as they live with Dorze people who are the creators as well as teachers of weaving in the area.

Table 1 also reveals that, mean vulnerability to food insecurity at Kamba District is 84 percent which is higher than the mean vulnerability to food insecurity at Chencha District (76 percent) and Denba Gofa District (55 percent). Thus, this descriptive data analysis reveals that rural households at low land area are more vulnerable to food insecurity than rural households in middle and high land areas. Moreover, from the total sample of 574 rural households, 392 (68 percent) of households are food in secured whereas the residual 182 (32 percent) sample households are food secured as presented in Table 1. Regarding food insecurity status of sample households in terms of ecology, from a sample of 160 rural households in Chencha District, 122 (73 percent) of sample households are food in secured while from a sample of 236 rural households in Kamba District, 182 (77 percent) of households are food in secured. Furthermore, from a total sample of 178 rural households in Denba Gofa District, 93 (52 percent) of sample households are food in secured. So, households in middle land area are relatively less vulnerable to food in security and have higher mean per capita consumption.

Table 1. Descriptive Statistics of Sample Households in terms of Ecological Zones

Variables	Chencha (160)		Kamba (236)		Denba Gofa (178)	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Kilocalorie Percapita	**1911.6**	**1770.3**	**1679.2**	**1362.6**	**2554.2**	**1976.7**
Age of HH Head	50.3	13.4	44.6	9.4	43.5	9.2
Years of Schooling	2.9	3.7	1.9	2.7	3.6	3.7
Dependency Ratio	0.3	0.2	0.5	0.2	0.5	0.2
Family Size	6.5	2.9	6.8	2.6	6.4	2.0
Land Size	1.0	0.8	0.6	0.6	1.1	1.2
Food Shortage	3.8	2.8	5.2	3.6	2.8	2.1
Off Farm Income	**1472.6**	**1770.7**	**200.4**	**421.2**	**498.8**	**785.7**
Farm Income	9304.4	8459.9	6633.5	11235.9	10620.5	7951.2
Tropical Livestock Unit	3.4	2.8	2.7	2.3	4.6	6.0
Consumption Percapita	537.5	433.0	487.1	370.4	699.1	517.5
Vulnerability	**0.76**	**0.4**	**0.84**	**0.4**	**0.55**	**0.5**
Food Insecurity	**0.73**	**0.25**	**0.77**	**0.32**	**0.52**	**0.21**

Source: Author's computation, 2018

As evidenced from Table 1, the mean monthly off farm income of Kamba District is 200.4 Ethiopian Birr which is lower than mean monthly off farm income at Chencha and Denba Gofa Districts. This implies the negative correlation between livelihood diversification and vulnerability to food insecurity in the study areas. Similarly, mean level of tropical livestock unit, annual farm income and land size of Kamba District are lower than that of Chencha and Denba Gofa Districts. Regarding vulnerability to food insecurity, the rural households in the study areas are classified as vulnerable and non-vulnerable households depending on the predicted future calorie per adult equivalent per day. After obtaining the calorie per adult equivalent per day, the study estimated the feasible generalized least square model to account for heteroscedasticity in the consumption data and predicted the future calorie per adult equivalent per day. Those sample households with predicted future calories per adult equivalent which are less than the minimum calorie requirement per adult equivalent per day are vulnerable to food insecurity whereas those sample households

with predicted future calorie per adult equivalent which are greater than the minimum calorie requirement per adult equivalent per day are not vulnerable.

Table 2. Distribution of Rural Sample Households by Vulnerability to Food Insecurity

		Chencha		Kamba		Denba Gofa	
		Vulnerable	Not Vulnerable	Vulnerable	Not Vulnerable	Vulnerable	Not Vulnerable
Food Insecure		115	2	175	7	84	9
Food Secure		8	35	24	30	15	70
Total	Frequency	123	37	199	37	99	79
	Percentage	76.87	23.13	84.32	15.68	55.62	44.38

Source: Author's Computation, 2018

As indicated in Table 2, vulnerability to food insecurity is more widespread in the study areas than food insecurity. Table 2 reveals that from a total of 182 currently food secured sample households, about 47 (8.2 percent) of sample households are vulnerable to food insecurity while from a total of 392 currently food in secured sample households, about 18 (3.1 percent) of sample households are not vulnerable to food insecurity in the study area. This is why it is not sufficient to use current food insecurity status as a proxy for whether someone will be food in secured in the next period or not. It might seem not surprising that about 135 (23.5 percent) of currently food secured households are not considered to be vulnerable in this study. This means that these households are currently food secured and they are considered to have a relatively low chance of being food in secured in the next period of time.

As presented in Figure 1, the mean calorie per capita per day at Denba Gofa District (2554.24) is higher than the mean calorie per capita per day at Chencha District (1911.63) and Kamba District (1679.23). Result in Figure 3 also revealed that households from low land areas are more vulnerable to food insecurity compared to households from middle and high land areas. Thus, rural households from moisture stress low land area are more likely to be food insecure and even more vulnerable as indicated in Figure 1 and 2.

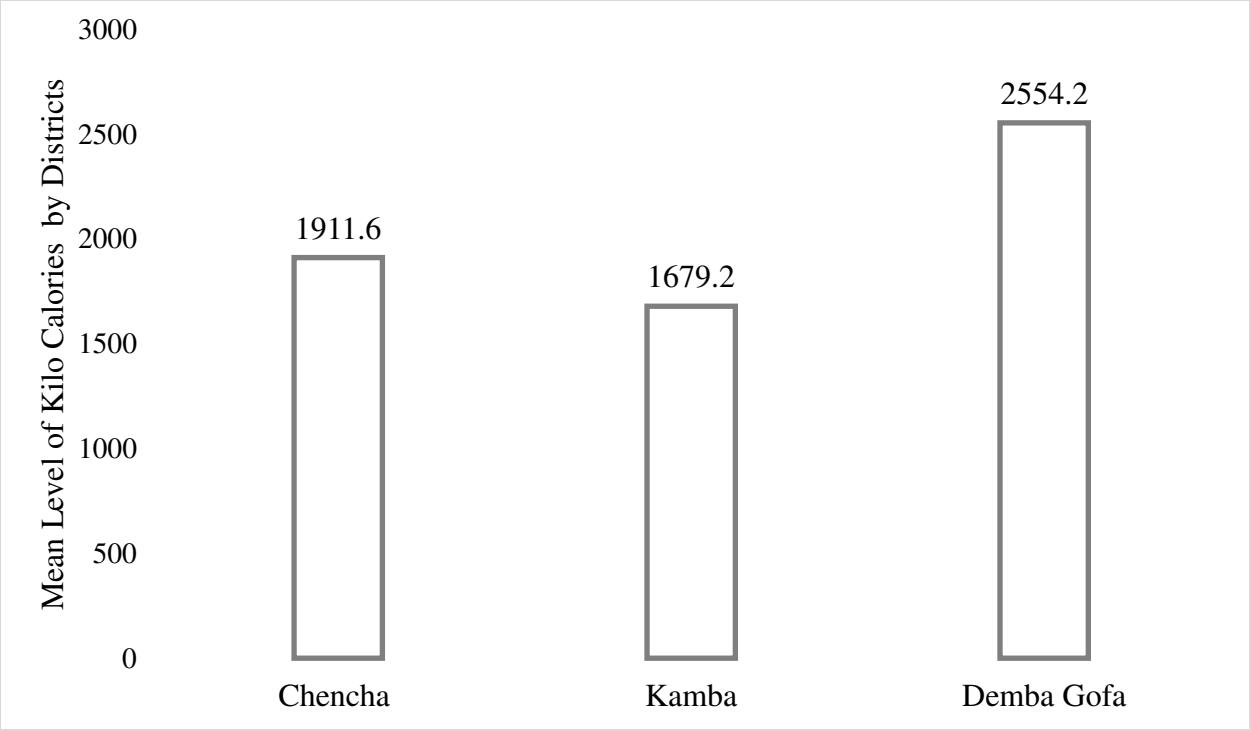

Figure 1. Mean Level of Kilo Calories by Districts in the Study Areas

Source: Author's Computation, 2018

As evidenced from Figure 2, the mean vulnerability to food insecurity of households from low land area is 84.3 percent whereas the mean vulnerability to food insecurity of households from middle and high land areas are 76.9 and 55.6 percent. The descriptive analysis also found that the mean per capita calorie per day for 392 food insecured rural households is 1189.2 while the mean per capita calorie per day for 182 food secured rural households is 3794.8 which is well above the minimum calorie requirement per day per adult equivalent of 2200.

As can be evidenced from Table 3, the mean age of household head, family size, dependency ratio, adult equivalent, distance from all season roads and distance from market which is measured in kilometers are higher for vulnerable households than non- vulnerable households in the study areas. On the other hand, the mean calorie per adult equivalent per day, years of schooling of household head, tropical life units and monthly consumption expenditure per adult equivalent are higher for not vulnerable households than vulnerable households. This implies that vulnerability to rural food insecurity increases with an increase in age of house hold head, family size, and distance from roads and nearby markets.

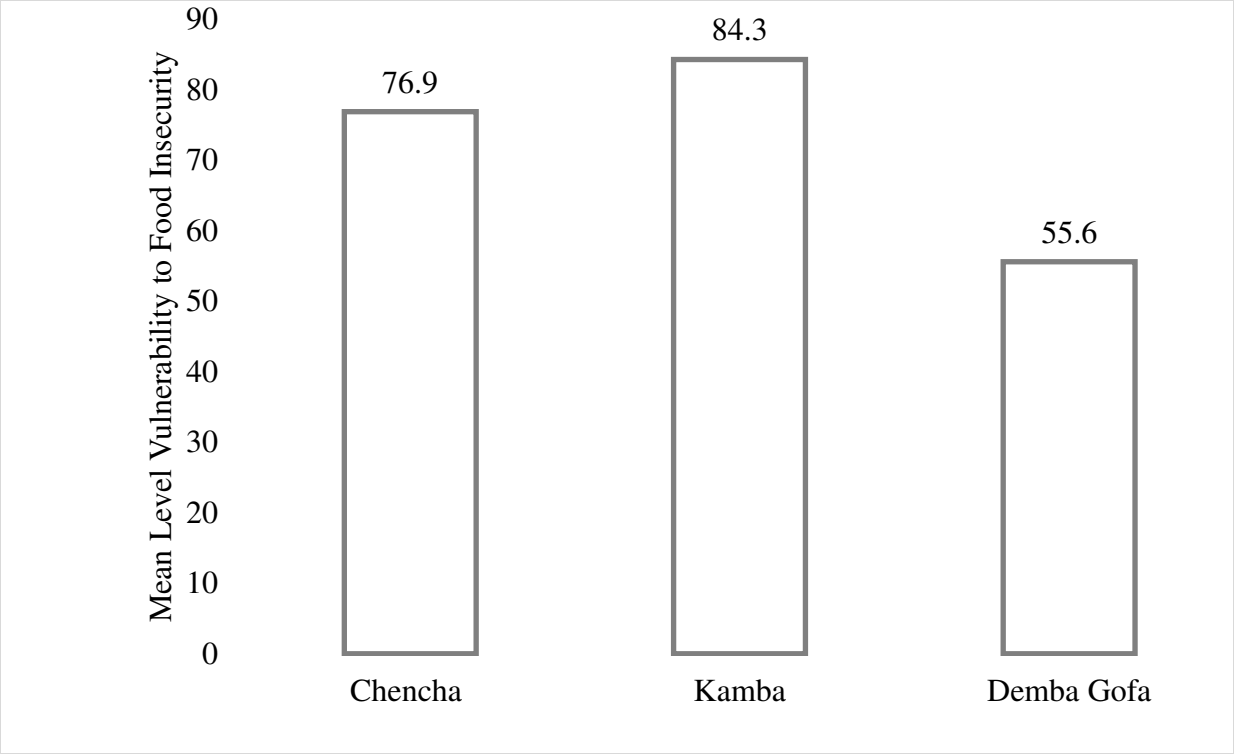

Figure 2. Mean Level of Vulnerability to Food Insecurity in the Study Areas by Districts

As age of household head increases, productive household members who contribute to the income of their family may leave the households due to marriage or out migration and this may increase the vulnerability of households to food insecurity. Similarly, rural households will benefit from crop and livestock production via market participation and market participation by itself depends on distance from all season roads and nearby markets. So, as distance from roads and market increase, households' participation in input and output market decrease and these increase the vulnerability of rural households to food insecurity.

One-way analysis of variance is used to test the mean difference of calorie per adult equivalent per day for sample households from three Districts. The result of the analysis of variance shows that there exists significant mean difference of calorie per adult equivalent per day for the three Districts as presented in Table 3. The probability of the third F statistics in Table 4 which is less than 5 percent indicates that the mean calories per adult equivalent per day at the three Districts are statistically significantly different from each other. In addition to this, the probability of the second F statistics which is still less than 5 percent shows that the grand mean of calorie per adult equivalent per day is statistically significantly different from zero.

Table 3. ANOVA Table of Calories Per Adult Equivalent Per Day by Districts

Source	Sum of Square	Df	Mean Square	F statistics	P value
Corrected Model	80070892.7	2	40035446.4	14.1	.000
Intercept	2344713162.1	1	2344713162.1	823.3	.000
District	80070892.7	2	40035446.4	14.1	.000
Error	1626251590.5	571	2848076.3		
Total	4037709795.0	574			
Corrected Total	1706322483.2	573			
Post hoc Test:					
Districts		Mean Difference	Standard Error	P Value	
Chencha	Demba Gofa	-642.57	183.85	.001	
	Kamba	232.42	172.83	.371	
Demba Gofa	Chencha	642.57	183.85	.001	
	Kamba	874.99	167.54	.000	
Kamba	Chencha	-232.42	172.83	.371	
	Demba Gofa	-874.99	167.54	.000	

Source: Author's computation, 2018.

However, the analysis of variance does not tell us the statistical significance of the mean difference between pairs of Districts. To this end, post hoc test is used to check whether there exists significant mean difference between two Districts in the study areas. Regarding the statistical significance of the mean difference between pairs of Districts, the result in Table 4 indicates that the mean calorie per adult equivalent per day of households at Demba Gofa District is significantly higher than the mean calorie per adult equivalent per day of households from Chencha and Kamba Districts at 5 percent level of significance.

Table 4. ANOVA Table of Households' Consumption Per Adult Equivalence Per Month

Source	Sum of Square	Df	Mean Square	F statistics	P value
Corrected Model	4749202.1	2	2374601.0	12.4	.000
Intercept	184488461.6	1	184488461.6	962.4	.000
District	4749202.0	2	2374601.0	12.4	.000
Error	109455103.9	571	191690.2		
Total	298674548.8	574			
Corrected Total	114204306.0	573			

Post hoc Test:

Districts		Mean Difference	Standard Error	P- Value
Chencha	Demba Gofa	-161.53†	47.70	.002
	Kamba	50.41	44.84	.499
Demba Gofa	Chencha	161.53	47.70	.002
	Kamba	211.94	43.46	.000
Kamba	Chencha	-50.41	44.84	.499
	Demba Gofa	-211.94	43.46	.000

Note: † consumption per adult equivalence per month is in Ethiopian birr

As evidenced from Table 5, the mean calorie per capita per day of vulnerable sample household head is greater than the mean calorie per capita per day of non- vulnerable households and the mean difference is statistically significant at 1percent level of significance. In addition to this, the mean age of vulnerable sample household head is greater than the mean age of non- vulnerable households and the mean difference is statistically significant at 1 percent level of significance. That means, older households are more likely to be vulnerable when it is compared to younger households. This is due to the fact that as age of household head increases, active household members may leave the household due to marriage or rural out migration, Babatunde et'al (2008) and Offiong Uma Ukpe (2016).

Table 5. Results of Mean Difference Test for Vulnerable and Non -Vulnerable Households

Covariates	Non-vulnerable	Vulnerable	Mean Difference	Std. Error	t -value
Calorie Percapita	3765.53	1379.31	2386.22	128.95	18.51***
Age of HH Head	41.98	47.19	-5.21	1.01	-5.14***
Years of Schooling	3.97	2.28	1.69	0.32	5.38***
Dependency Ratio	0.35	0.47	-0.12	0.02	-5.57***
Family size	4.68	7.28	-2.60	0.21	-12.2***
Land Size	0.73	0.93	-0.20	0.09	-2.29**
Food Shortage	2.94	4.50	-1.56	0.29	-5.31***
Off farm income	571.67	675.11	-103.45	112.22	-0.92
Farm Income	6359.98	14817.76	-8457.78	845.89	-10.0***
Tropical Livestock Unit	3.12	3.59	-0.47	0.38	-1.25
Distance from Road	1.36	4.22	-2.86	0.46	-6.27***
Distance from Market	1.96	4.80	-2.84	0.35	-8.08***
Consumption Percapita	960.55	423.84	536.71	35.72	15.03***

Source: Author's computation, 2018

4.2 Logistic Regression Results

In order to project future calorie percapita per day, first the model of calorie consumption percapita is estimated whereby calorie consumption per capita is a function of a number of household characteristics. Since the residuals that will be generated by this estimation may correlate to each other and exhibit different variances, the model is unable to capture all the systematic variability of the dependent variable. In the second step, the squared residuals of the first model is regressed on all observable charactertics and the variances of this second model is determined. Finally, in the third steps, the variance which is obtained from the second equation is used to correct the first model of calorie consumption percapita for heteroscedasticity.

The corrected calorie consumption percapita is used to project the future consumption of households and those households whose predicted calorie percapita consumption is below the minimum thresholds, 2200 are considered as vulnerable to food insecurity and those households

whose future calorie consumption percapita greater than the minimum calorie requirement per adult equivalent per day are considered not vulnerable to food insecurity.

Thus, to examine the possible determinants of vulnerability to food insecurity in the study areas, the predicted future calorie consumption is used to categorize households as vulnerable and not vulnerable. That means, if the predicted future calorie consumption of household is less than 2200, the household is vulnerable to food insecurity and if the predicted future calorie consumption per adult equivalent per day of household is greater than 2200, the household is not vulnerable to food insecurity.

Since the dependent variable is dichotomous, our preferred model to examine the determinants of vulnerability to food insecurity in this study is the logistic regression where the estimation results are presented in Table 4. As F test is used to evaluate the joint significance of all variables in ordinary least square method of estimation, Wald test or likelihood ratio test is used to assess the overall significance of all variables in maximum likelihood estimation. As indicated in Table 4, the Wald statistics is large or the probability of observing values of Wald statics greater than or equal to 110.54 which is less or very close to zero. Therefore, the null hypothesis of no relationship between all independent variables and the outcome variable is rejected at 1 percent level of significance. Though it is not dependable in maximum likelihood estimation, the Pseudo R^2 , which is another overall test of significance, becomes relatively higher.

As presented in Table 4, age of household head, family size, adult equivalent, off farm income, participation in safety net programs, distance from health center in kilometers, death of household members and death of animals which are positively and statistically significantly affect rural household vulnerability to food insecurity as measured through kilocalorie intake method in the study areas. But, farm income, participation in irrigation use, credit uses and area dummy for Denba Gofa District are negatively and statistically significantly affect rural households' vulnerability to food insecurity as indicated in Table 4. Age of household head carried a significant positive sign and this may be due to the fact that as age of household head increases, some productive household members may leave their family due to education, marriage and other reasons. Family size carried a significant positive sign indicating that households with more family size are more vulnerable to food insecurity when it is compared to households with less family size. Similar finding has been reported for Ethiopian in study conducted by Beyene (2010).

Table 6: Logistic Regression Result of the Determinants of Vulnerability to Food Insecurity

Wald chi-square (25) =110.54		Pseudo R2=0.7667	
Probability>chi-square =0.0000			
Covariates	Logit Coefficients	Marginal Effect	Z-value
Age of HH Head	0.03537	0.0006	2.05**
Family Size	0.49735	0.00848	3.45***
Years of Schooling	-0.08671	-0.001479	-1.25
Female	0.76957	0.018178	0.79
Adult Equivalent	0.92578	0.0157918	5.09***
Farm Income	-0.00042	-0.0000715	-2.88**
Land Size	0.82438	0.0140621	1.35
Participation in Equib	1.52453	0.042428	1.63
Participation in Irrigation	-1.72828	-0.0548121	-2.55**
Urban House Ownership	-3.2436	-0.1959851	-3.76***
Off Farm Income	0.000821	0.000014	2.90**
Participation in SNP	0.000824	0.000014	3.97***
Credit Uses	-0.99882	-0.020198	-1.92*
Distance from Road	0.06079	0.0010369	0.57
Distance from Market	0.00978	0.0001669	1.54
Distance from Health Center	0.54329	0.0092667	2.3**
Death of Animals	2.42063	0.0472874	4.46***
Death of HHs member	2.94851	0.0417082	3.91***
Chencha	-0.60092	-0.0118195	-0.78
Demba Gofa	-5.07929	-0.3645219	-4.28***
Constant	-10.51811		-5.11***

Source: Author's Computation, 2018

Quite unexpectedly, the coefficients of participation in safety net program and off farm income are positive and statistically significant at 1 perecent level of significance. This is due to the fact that most of the participants in off farm activities are food in secured in the study areas. For instance, from a total sample of 574 respondents in this study, 268 (47 perecent) of respondents reported

that they participate in off farm activities. Besides, from 268 off farm participants, 164 (61 percent) of the respondents are vulnerable households. Regarding, participation in safety net program, participants may use the money obtained via the program for unproductive activities rather than using the money for asset building.

The result of the logit estimation in Table 4 also reveals that the coefficient of urban house ownership of household is positive and significant at 1 percent level of significance. That means, on average, households who have their own house at urban areas are less vulnerability to food insecurity as they make money by renting out their houses. As evidenced from Table 4, vulnerability to food insecurity, on average, decreases by 19.6 percent for households with houses at urban areas when it is compared to those households with no houses at urban areas. In addition, unexpected shocks to rural households like death of animals and death of household members, increase the probability of being food in secured in the near future as indicated in table 6 and the relationships are statistically significant at 1 percent level of significance. The coefficient of participation in irrigation carried a significant negative sign which shows that water is important natural resource to build resilience to food insecurity. As showed in Table 4, vulnerability to food insecurity decreases by 5.5 percent for irrigation users when it is compared to non-users. Diagnostic test results of the above model also revealed that there is no multicollinearity and model mis-specification.

5. CONCLUSIONS

Food insecurity and poverty are the most challenging development problems in developing countries in general in Ethiopia in particular. Agriculture is the back bone of Ethiopia economy as about 80 percent of the population are employed in this sector. However, the agricultural sector is still the most vulnerable sector to climate change due to the fact that Ethiopia agriculture heavily depends on rain fall. So, since the lives and livelihoods of most rural people are married with agricultural production and agricultural activities depend on climate, rural farm households are more vulnerable to food insecurity. So, examining the level and factors contributing to vulnerability to food insecurity and resilience to food insecurity has paramount importance for policy makers or any other stakeholders. This study measured the level of food insecurity, vulnerability to food insecurity and examined the determinants of rural households' vulnerability to food insecurity using a random sample of 574 rural households and the feasible generalized

least square method of estimation in Southern Ethiopia. To measure household level vulnerability to food insecurity in the study areas, the methodology which is developed by Chaudhuri (2000) and which depends on kilocalorie percapita consumption was used in this study.

The mean kilocalorie per adult equivalent per day at Chencha, Kamba and Denba Gofa Districts are 1911.6, 1679.2 and 2554.2 respectively. The study revealed that, mean vulnerability to food insecurity at low land area, Kamba district (84.3 percent) is higher than the mean vulnerability to food insecurity at high land area, Chencha District (76.9 percent) and middle land area, Denba Gofa District (55.6 percent). The study also found that from a total of 574 rural sample households in the present study, 392 (68.3 percent) of sample households are food in secured while the residual, 182 (31.7 percent) of sample households are food secured in the study areas.

Furthermore, from a total of 160 sample households at Chencha District, 117 (73 percent) of sample households are food in secured while from a total of 236 and 178 sample households at Kamba and Denba Gofa Districts, 182 (77 percent) and 93 (52 percent) of sample households are food in secured, respectively. Regarding vulnerability to food insecurity, from a sample of 574 rural households, 421(73 percent) of sample households are vulnerable to food insecurity. The result of the study found that vulnerability to food insecurity is more widespread in the study areas than food insecurity. Similarly, from a total of 182 currently food secured sample households, about 47 (8.2 percent) of sample households are vulnerable to food insecurity while from a total of 392 currently food in secured sample households, about 18 (3 percent) of sample households are not vulnerable to food insecurity in the study area. The logistic regression result revealed that, age of household head, family size, adult equivalent, off farm income, participation in safety net programs, distance from health center in kilometers, death of household members and death of animals are positively and statistically significantly affect rural household vulnerability to food insecurity as measured using kilocalorie intake method in the study areas. But, farm income, participation in irrigation use, credit uses and area dummy for Demba Gofa District are negatively and statistically significantly affect rural household vulnerability to food insecurity.

Hence, to reduce the vulnerability of rural households to food insecurity, government need to provide credit services to rural poor youth to help them participate in off farm activities and escape from rural food insecurity in general and vulnerability to food insecurity in particular. Moreover, encouraging rural households' participation in small scale irrigation works will build the resilience and reduce their vulnerability to food insecurity. Reducing women fertility via education, better

job opportunities and awareness creation may help to control rapid population growth and lessen the pressure on scarce agricultural resources in rural areas. Besides these, promoting rural urban linkages in terms of the flow of goods, people, capital, services and information may also help rural poor households to build resilience to food insecurity owning to livelihood diversification.

Declarations

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Availability of data and materials:

The data that support the findings of this study can be obtained from the authors upon request

Ethics approval and consent to participate:

Not applicable

Conflict of interests:

The authors declare that they have no competing interests.

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Figures

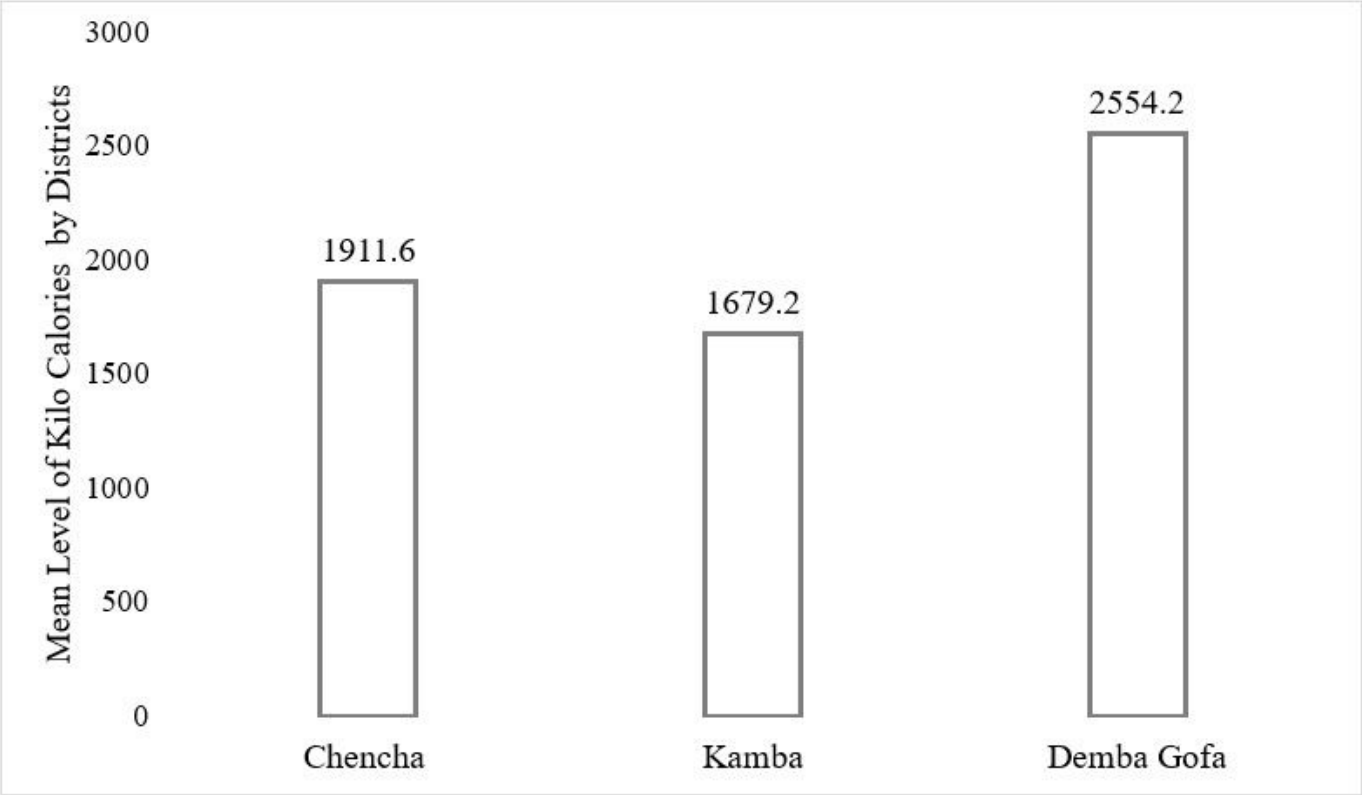

Figure 1

Mean Level of Kilo Calories by Districts in the Study Areas Source: Author's Computation, 2018

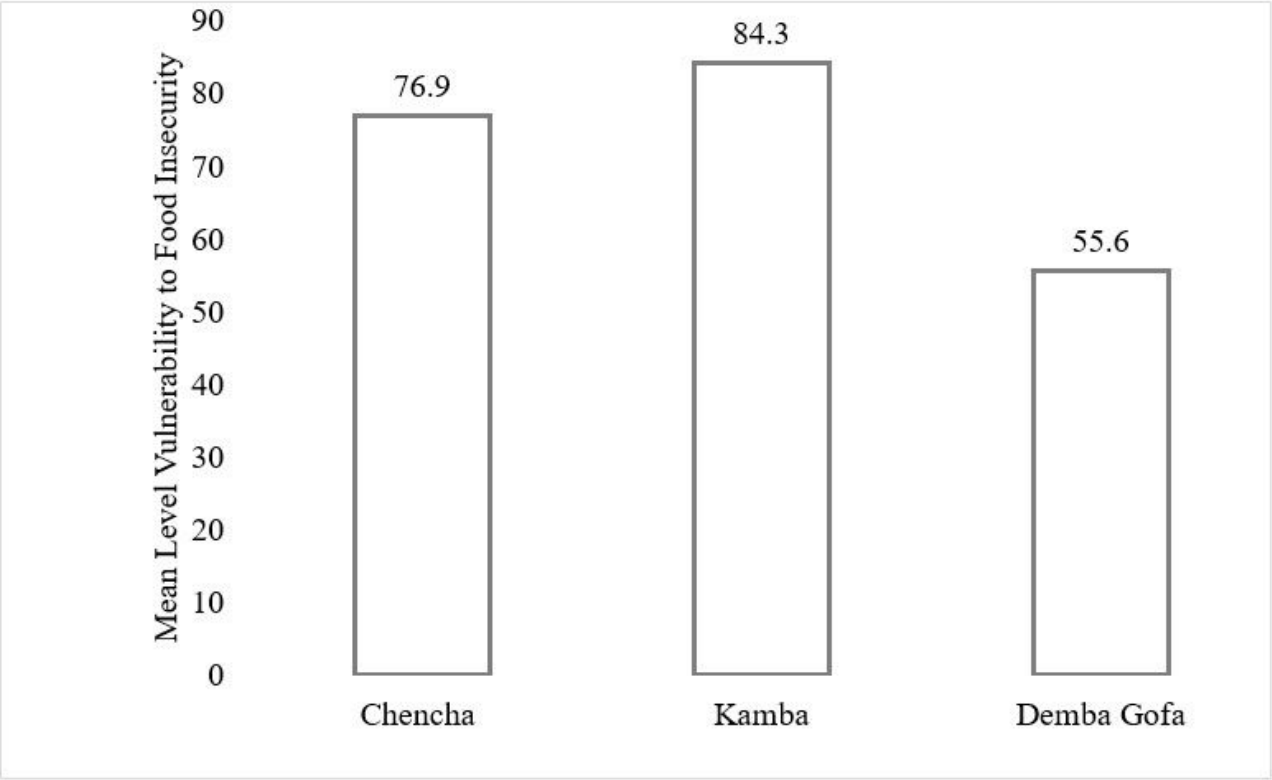

Figure 2

Mean Level of Vulnerability to Food Insecurity in the Study Areas by Districts