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Determinants of seasonal food insecurity in the 'green famine' belt of Ethiopia: The case of households in Belo-jiganfoy District, Benishangul-gumuz region

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Despite enormous body of literature on household food insecurity and its determinants in the *non-green belt* of Ethiopia, such a research is scanty or nonexistent in the 'green famine' belt. The objective of this study was to examine factors determining household food insecurity in the 'green famine' belt of Ethiopia. Logistic regression model was employed to analyze the data collected through cross-sectional survey of 220 households selected from Belo-jiganfoy district. The study revealed that food insecurity was significantly determined by demographic, socioeconomic and technological factors. The effects of household size, participation in local labor unions and farming systems on food insecurity were positive while that of the use of extravagant consumption, small-scale irrigation, aggregate production, and education of household head were negative. Therefore, the study recommended that interventions should target at these most significant variables when attempting to build household resilience to food insecurity.

Key words: Food insecurity, determinant, logistic model, *'green famine'*, Ethiopia.

INTRODUCTION

Ethiopia's economy has been growing on average by a double digit rate since 2004 (IMF, 2014). Perhaps following this fast economic growth, food security status at national level has shown improvements over the last two and half decades. Food insecurity at national level had declined from approximately 52% in 1980s to 43% in 1995/96 (Devereux, 2000), but stayed almost the same at about 44% in 2003 (USAID, 2004). From this status, it had declined to 38.7% in 2004/05 and further to 35.6% in 2005/06. Then, it came down to 33.3% in 2006/2007 and 28% in 2009/10 (MoFED, 2008). Despite the fast economic growth and declining trend in food insecurity status at national level, empirical research shows that food insecurity at household level has remained considerably high in many parts of the country. A surprising feature of food insecurity in Ethiopia is its situation in the 'green famine' belt, the area that generally represents the western half of Ethiopia characterized by adequate rainfall, green vegetation cover, almost absence of drought, low population pressure, and better

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land resource endowments (Guyu, 2015). In Benishangul-gumuz region (BGR) as a whole, about 58% of the population was food insecure in 2004 (BGRFS, 2004). Empirical studies at community and household levels in different districts of the region show that food insecurity (proxy indicator of 'green famine') is deep-rooted in the region. A qualitative study of *semi-pastoral communities* indicates that poverty and food insecurity in the region in general and in Dibate district in particular were severe (Guyu, 2012). According to this study, mainly people among the indigenous ethnic group (particularly the Gumuz) resorted to depend on wild foods as coping mechanism. The other work, such a dependence on wild foods was found to be an indicator of food sovereignty of households as they preferred to this source of food to food market (Guyu and Muluneh, 2015). The proportions of food insecure households were 85% in Assosa district (Dagnachew, 2004) and 58% in Bullen district (Guyu, 2014), both being in BGR. A parallel study in Belo-jiganfoy district showed that the majority of households were food insecure by all standards (Guyu, 2015). Moreover, the analysis of resilience-vulnerability continuum in the same district revealed that about 65% of households were vulnerable while only about 35% of them were resilient to food insecurity at different levels (Guyu and Muluneh, 2015). This shows that food insecurity has remained one of the most considerable challenges of the region despite the relative suitability of conditions for agricultural production.

According to FAO (2010), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Household food insecurity is the application of this concept to at household level, with individuals within household as the focus of concern (FAO, 2010; Canali and Slaviero 2010). In Ethiopian context, household food insecurity exists when a household is not capable of sufficiently feeding its members from either its own production or purchase from the market, in return to own cash that might be earned from the exchange of self-endowment (Degefa, 2005). In this manuscript, household food insecurity is used as a proxy indicator of 'green famine'

'Green famine' exists when people face the challenges of acute food shortage leading to hunger or starvation but when such acute shortage of food occurs in areas characterized by environmentally and demographically favorable conditions for agricultural production (Guyu, 2015; Guyu and Muluneh 2015). The concept was initially used in Mulugeta (2014) as an official academic research topic conducted in Southern Ethiopia although the idea of 'green famine' in Ethiopia was mentioned earlier by some authors (Alemayehu, 2001) and foreign media such as Agence France-Press [AFP] (2008). The concept of 'green famine' used in Mulugeta (2014) is entirely dependent on the suggestion of Alemayehu (2001), both located in 'enset' producing southern highlands of Ethiopia. But these areas are characterized by high population pressure, fragmented and degraded lands and, occasional occurrences of droughts but considered as everything is 'green' there. The concept is then redefined by adapting to the situations in Western Ethiopia in Guyu (2015) and became more mature in Guyu and Muluneh (2015), both sources using seasonal food insecurity as a proxy indicator of 'green famine', in which the area itself is termed as 'green famine' belt (GFB) of Ethiopia. In the later sources, 'greenness of everything', as opposed to Alemayehu (2001) and Mulugeta (2014), is defined for not only adequate rainfall and vegetation but also adequate availability of farmland as a result of low population density and existence of little or no drought. Therefore, the phrase food insecurity and 'green famine' in this paper are used synonymously. By definition and based on the empirical reviews, the GFB in general and the case study area in particular is vulnerable to 'green famine' or seasonal food insecurity. The question in this paper is what determines household's food insecurity status (that is, a proxy indicator of 'green famine') in the GFB of Ethiopia?

The causes of household 'green famine' are related primarily and heavily to agricultural production. Different theories that explain the causation of food insecurity can be used to understand the factors that determine 'green famine'. The first is the demographic theory explanation of food security, which in turn is divided into two different perceptions held by different thinkers, primarily Thomas Malthus and Easter Boserup. Thomas Malthus (1766-1834) argues that population tends to increase faster than the food supply because rapid population growth results in tremendous land degradation leading to the down spiral of agricultural productivity and the decline in per capita food supply for consumption (Degefa, 2005). According to the neo-Malthusian theory, increasing and high population, if remain unchecked, leads to famine and food shortages. Contrary to the Neo-Malthusian views, Boserup argues that increasing and large population stimulates agricultural development and ensures increased level of food supply (Boserup, 1965). Both theories are however criticized for they are merely availability-oriented models but have been used as theoretical foundations for understanding causes of failures in food availability. However, food insecurity is not caused by factors that determine availability component alone. Rather, models used to capture and comprehensively understand the determinants of food insecurity should include all components of food security: Availability, accessibility and utilization as well as stability (Gross et al., 2000) and, sovereignty too.

Another theory that can be used to explain causes of famine and food insecurity is supply-demand explanation of food insecurity (Shiferaw et al., 2003). According to this theory, determinants of food insecurity can be divided into two: Supply-side determinants and demand-side

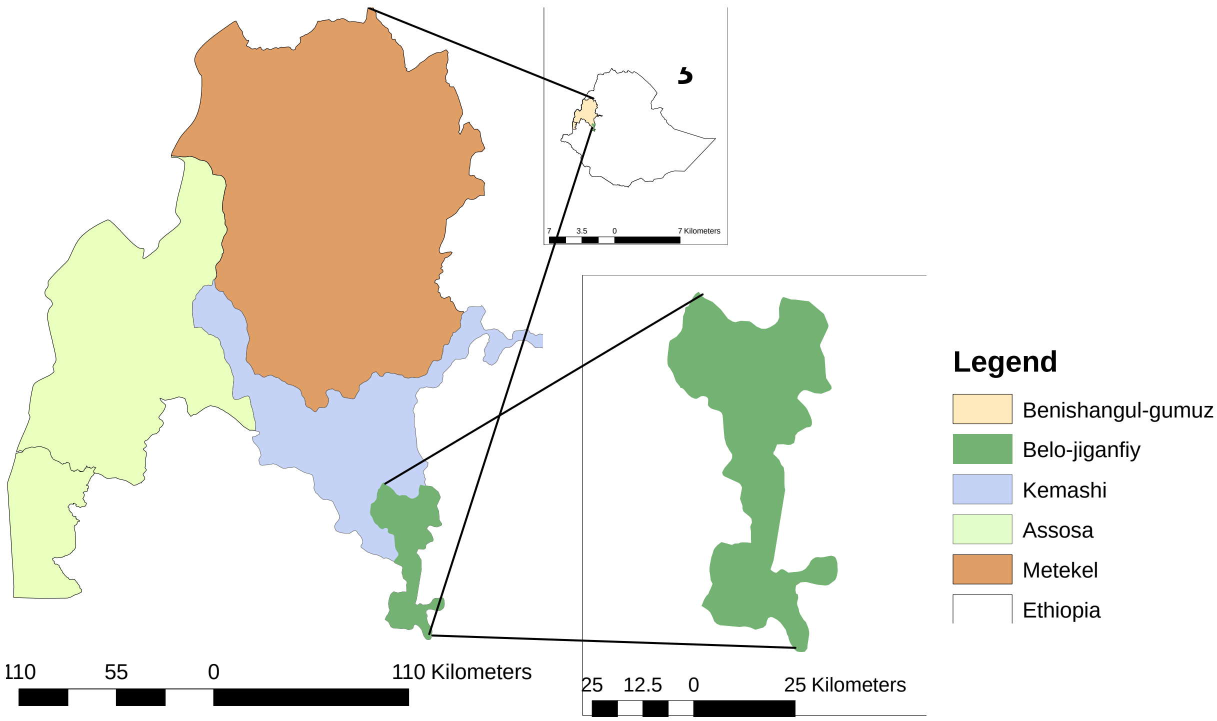

Figure 1. Location map of the study area.

determinants. Supply-side factors can be technology adoption, farming system, farm size and, land quality while demand-side factors can include household size, market access, per capita aggregate production, wealth (that is, livestock possession), and access to off-farm work (Shiferaw et al., 2003). In this study, however, we used a model that uses a combination factors from different theories and indicators of food security/insecurity in order to achieve a comprehensive understanding of the determinants.

In literature, different authors have identified different factors that determine food security/insecurity in developing countries including Ethiopia. In Ethiopia, these include biophysical, lack of access to livelihood assets, constraints to livestock, access-related constraints such as lack of opportunities, start-up capital, knowledge and skills, and inappropriate land right arrangements (Degefa, 2005; Bashir et al., 2012; Aidoo et al., 2013; Shiferaw et al., 2003; Haile et al., 2005; Bogale and Shimelis, 2009; Canali and Slaveiro, 2013). With regard to causes of 'green famine', little or no studies have been conducted in general and in GFB and our study area in particular. Although purely qualitative, Mulugeta (2014) examines some underlying causes and trigger factors of 'green famine'. However, as far as our reading is concerned, there is no study that examined the determinants of 'green famine' statistically in the GFB and it is totally absent in the case study area. This is perhaps because the national research and policy actions tend to focus on the drought-prone parts of the country. We believe that such a tendency that overlooks the relatively greener western part of Ethiopia cannot bring the overall national development goals in general and food security objectives in particular. The reminder of this paper is that the challenges of food insecurity in the GFB of Ethiopia is at least equivalent to, otherwise more than, the drought-prone eastern half of the country and needs at least equal attention in taking actions through research and policy if the overall national objective of ensuring sustainable food security is to be achieved. In light of this, the paper aims at statistically examining and documenting the main determinants of food insecurity in the GFB of Ethiopia based on a selected case study district. Doing so, the study provides an insight into the nature of food insecurity ('green famine') and its determinants so that researchers and policymakers that are interested in further research and implementation of policy measures respectively may use the model for addressing food insecurity challenges especially at household level.

MATERIALS AND METHODS

The study was conducted in the GFB of Ethiopia by taking Belo-jigafoy district as a case study area. The GFB is generally located in Western half of Ethiopia where BGR is a part. BGR is one of the 9 federal states of Ethiopia located in western and relatively greener part of the country. It is located between 09°17' to 12°06' Northing and 34°10' to 37°04' Easting (Figure 1). A cross-sectional survey was conducted in Belo-jiganfoy district, western Ethiopia in 2013. Data for measuring the status and determinants of household food insecurity were collected through a structured questionnaire. The questionnaire includes information on sources of food, as well as demographic and socioeconomic determinants of food insecurity. Accordingly, the dependent variable in the study is food insecurity (Y), which is one of the negative outcomes of household livelihoods, the positive outcome being food security. It was assumed that food security/insecurity is a function of socioeconomic, cultural and demographic factors.

$$Y_j = f\{X_{1j}, X_{2j}, X_{3j, \ldots,} X_{ij}\} \quad (1)$$

Where; Xij represents the i^{th} determinant for the j^{th} household. Y_j represents the food insecurity status of the $_j^{th}$ household.

The overall food security status is a binary outcome variable that takes a value of 1 if a household is food insecure, 0 otherwise. Thus, the food insecurity of the i^{th} household (Y_j) is therefore given as follows:

$Y_j = 1$, if $K_i < Z$; and $Y_i = 0$, if $K_i \geq Z$

Where, K_i is the per capita kcal/ADE/day for i^{th} household, and Z is the food security line (i.e. the minimum required kcal/ADE/day). The determination of food insecurity status involves certain procedure. It was determined based on five steps following the foot-steps of Haile et al. (2005). First, household food balance model (HFBM) was used to determine the net available food (NAF) for each household based on Equation 1. The model was used to calculate the NAF as the difference between the gross available food (GAF) and food disposed due to various reasons (FDSP). The HFBM was originally adapted by Degefa (1996) from FAO regional food balance model (Messay, 2013) in the Ethiopian context and then used by many other authors (Haile et al., 2005; Messay, 2009a; Guyu, 2014; Guyu, 2015). Second, the NAF was converted to total kilocalories for each household and then to ADE based on conversion factors provided by the 1998 Ethiopian Health and Nutrition Research Institute (EHNRI). Third, the kilocalories per kilogram calculated in step two were compared with the minimum per day per ADE subsistence calories required by an adult to live a healthy and moderately active life in Ethiopia which is set at 2100 kcal. This threshold was used as a cut-point between food insecure and food secure households in this paper.

$$NAF = (GAF - FDSPL) = (OPF + FP + FB) - (FS + SR + PHL) \quad (2)$$

Where; NAF = Net available food/dietary energy supply; GAF = gross available food; FS = food sold; FDSPL = food disposal; SR = seed reserved; OPF = own food produced; PHL = post-harvest loss; FP = food purchased; FB = food borrowed.

Food security/insecurity is a binary categorical response variable in this paper. Different options of models are available for analyzing a categorical dependent variable. Linear regression model is a commonly method used in many studies. It is, however, applied when the dependent variable is measured on a continuous scale. For a binary response variable, discriminant analysis and logistic regression method are widely used but of them have limitations. Discriminant analysis is used if all predictors are continuous and nicely distributed. Logit (loglinear) analysis is often used if all predictors are categorical although the dependent variable is always categorical. Finally, logistic regression is often chosen if predictors are mixed and/or if they are not nicely distributed. In other words, logistic regression makes no assumption about the distribution of explanatory variables for best prediction of binary outcomes. The probit model is an alternative to logistic model because they either of them can be used for a categorical dependent variable. While probit is based on standard normal distribution, the logit is based on standard logistic distribution. According to Sodjinou et al. (2015), these two models often lead to the same conclusion and it is difficult to make a choice between the probit and the logit on theoretical bases. In this paper, we used the binary logistic regression method for its advantages over others. It assumes that the dependent variable is linearly related with the predictors. The dependent variable (**Y_j**) is defined as 1 if a household is food insecure, otherwise 0 ($_j$ ranging from 1 - 220) and given as follows:

$$Y_j = \beta_0 + \beta_1 X_{1j}, \beta_2 X_{2j,} \beta_3 X_{3j, \ldots,} \beta_i X_{ij} + e \quad (3)$$

Where; Y_j is the dependent variable; β_0 is a constant value that represents the Y intercept; $\beta_1, \beta_2, \beta_3, \ldots, \beta_i$ are coefficients or slopes of $X_1, X_2, X_3, \ldots, X_i$ respectively, and $X_1, X_2, X_3, \ldots, X_i$ are explanatory variables, i is the number of coefficients and j is the number of observations, and e is error term. Statistical Package for Social Sciences (SPSS) version 19 was statistical tool or software used for analyzing the data.

Hypothesized variables influencing household food insecurity

The following 16 potential explanatory variables were selected and hypothesized based on literature and the authors' observation of the study area.

Household size in ADE (continuous) (HHSZADE)

This is a count variable expressed in adult equivalent (ADE) that is expected to influence household food insecurity. There is no clear relationship between household size and agricultural productivity and hence food security in literature. Some argue that large household size increases crop productivity and improve food supply while others disagree with idea. The acceptance of either idea depends on the nature of the activity and the degree of involvement of labor force into the work. The Boserupean theory of agricultural change argues that households with more family size (labor supply) tend to produce higher crop yield per unit of area (Boserup, 1965). Following this theory, some authors hypothesized and proved it to have positive relationship with agricultural yield, for example, in organic cotton production in Benin which needs labor intensive production system although it has insignificant influence (Sodjinou et al., 2015). On the other hand, most authors showed that household size has positive influence on food insecurity (Shiferaw et al., 2003; Haile et al., 2005; Bogale and Shimelis, 2009; Bashir et al., 2012; Aidoo et al., 2013). One obvious reason for this is that as household size increases, the number of mouths to feed from the available food increases (Bogale and Shimelis, 2009). Observation in most areas of Ethiopia shows that farm households are small-scale subsistence or semi-subsistence producers with limited participation in the non-agricultural sector. In this case, as resources are very limited, the increasing household size may put more pressure on consumption than it contributes to production. Under such a situation, food requirements increase with the number of persons in a household (Shiferaw et al., 2003; Haile et al., 2005). As a result, we expect a positive relationship between household size and food insecurity in our study area.

Cultivated land size per household (continuous) (LCULTD)

Generally, literature shows that land size and agricultural yield have positive relationship (Sodjinou et al., 2015). Other things being constant, cultivated farmland size measured in hectares has also negative relationship with the probability of being food insecure (Bogale and Shimelis, 2009; Aidoo et al., 2013). Access to, and cultivation of, land decreases the likelihood that the household will be food insecure. In this paper too, cultivated land size is hypothesized to have negative influence on household food insecurity.

Irrigation use (dummy) (IRRUSE)

There is a general consensus among literature that use of irrigation has a negative influence on the probability of being food insecure (Bogale and Shimelis, 2009). In this paper, we also hypothesized that farm households' use of small scale irrigation has a negative influence on food insecurity. The idea is that households who practice small scale irrigation can produce more output than those who do not and the likelihood of these households to become food insecure is less. Especially, its benefits are bold when rain-fed agriculture failures occur for various reasons.

Education of household head (continuous) (HEDUY)

This variable is measured in terms of years households stayed in schools. Literature shows that the likelihood of being food insecure decreases as the number of years a household head stayed in schools increases (Haile et al., 2005). The assumption is that education equips individuals with the necessary knowledge of how to make a living. That is, literate individuals are keen to get information and use it (Bogale and Shimelis, 2009). In other words, educated producers are able to read manuals and other extension materials, accessible to information through media and can communicate with extension services (Sodjinou et al., 2015). In this paper too, we expect a negative influence of education of household head on the probability of being food insecure.

Off-farm income (continuous) (off-farm)

This is a continuous variable measured in Eth birr. Literature shows that the likelihood of being food insecure decreases as access to and earning of money through off-farm income increases (Omotesho et al., 2006; Bogale and Shimelis, 2009). Following this assumption of general literature, we also proposed that off-farm income has negative relationship with food insecurity. The idea is that as households have more and more access to and practice of these activities, their likelihood of being food insecure will decrease.

Dependence on wild foods (dummy) (DWFs)

This refers to gathering and hunting wild foods by households. Although no literature was found that analyzed WEFs as a determinant of food insecurity, literature shows their contribution to household food security (Debela et al., 2011; Agea et al., 2011; Guyu, 2015) and to household resilience to food insecurity (Guyu and Muluneh, 2015). Accordingly, WEFs is hypothesized to influence food insecurity negatively in the study area. The assumption is that households can compensate food shortages by gathering and hunting wild foods. In other words, households that are more involved in gathering and hunting WEFs improve their food security than those who depend less on them.

Livestock possession (continuous) (TLU)

Literature shows that livestock possession has negative influence on household food insecurity (Messay, 2009). The idea is that livestock can be sold in order to purchase food during food shortages (Bogale and Shimelis, 2009). Following this, it is expected to have a negative influence on household food insecurity in our study area.

Participation in labor unions (dummy) (LBRUPTC)

This refers to whether household members participated in labor union, locally known as *wenfel* or *debo*. It is expected to influence household food insecurity negatively. The assumption is that households that work together through such local labor unions are less likely to be food insecure than those who do not.

Ethno-culture background (dummy) (ETHCBGD)

This refers to whether households belong to indigenous or non-indigenous ethnic group (Guyu, 2015). It is expected that the probability of being food insecure increases for indigenous than the non-indigenous ethno-culture group. Accordingly, being indigenous ethno-culture group is hypothesized to have positive influence on household food insecurity in our study area.

Age of household head (continuous) (AGEHH)

Age of household head is expected to influence household food security. Nevertheless, there is no general consensus as to the direction of the influence of age on food security in literature. For example, Sodjinou et al. (2015) argue that the relationship between farmers' age and the decision to adopt an innovation or technology is not clear in the literature. Some argue that a one year increase in age of household head increases the probability of being food secure (Bogal and Shimelis, 2009). Proponents of this argument assert that age of household head is negatively related with food insecurity for various reasons. Rural households mostly devote their lifetime or base their livelihoods on agriculture. The older the household head has more experience in farming and weather forecasting. Moreover, older persons are more risk averters, and mostly they tend to diversify their production activities. As a result, the chance for such a household to be food insecure is less. In addition, in a household where productive age groups are higher than the non-productive age groups, the probability of a household to face food shortage would be less, provided that the area provides good working atmosphere and production potential (Bogal and Shimelis, 2009). In contrast, others argue that it is positively related with household food security. That means, a one year increase in the age of household head decreases the chances of being food insecure (Bashir et al., 2012; Aidoo et al., 2013). The proponents of this argument assert that the direct relationship between age of household head and food security is due to the fact that the younger people are stronger than the elders and can perform tougher jobs in the field. Moreover, households with older heads are the multigenerational households having more retired and/or older persons to feed (Bashir et al., 2012). Based on the general observation of the study area, we expect a negatively influence of age of household head on food insecurity as at least older age is associated with adequate experiences than younger one.

Health condition of household members (continuous) (HEALTH)

This variable refers to the frequency of illness or sickness of members of a household during the year. This variable is expected to influence food insecurity positively in the study area. It is assumed that the more frequently the household members get sick, the more they will be food insecure and vice versa.

Aggregate agricultural production (continuous) (AGRPD)

This refers to the total amount of agricultural production (measured in kg) obtained by a household without considering the deductions through selling, seed reserves, losses due to attacks by rodents,

Table 1. Descriptive statistics of kcal supply by food security status and ethno-culture group.

Kcal/ ADE/day	Food security status			Ethno-culture group		
	Food-insecure	**Food-secure**	**Both**	**Non- indigenous**	**Indigenous**	**Both**
Total	168530.6	220112.5	388643.0	197469.3	191173.7	388643.0
Minimum	0.01	2107.9	0.01	65.01	0.01	0.01
Maximum	2069.1	8899.48	8899.48	8028.20	8899.48	8899.48
Average	1066.7	3550.2	1766.56	1994.64	1579.95	1766.56
STD	462.8	1546.5	1440.06	1590.82	1280.56	1440.06

insects, etc. In principle, it should consist of both crop and livestock production. However, in this study the outputs of various crops alone are considered as livestock in TLU were taken as one variable in the model. Literature shows a disagreement as to the direction of the influence of this variable on food insecurity. Some show that aggregate production has a positive influence on household food insecurity through the price effect (Shiferaw et al., 2003). The assumption is that an increase in aggregate production causes price to fall and hence those households whose income is dependent on food crops face a fall in farm income. The higher the market supply, the lower the price, and hence the higher the loss of producer revenue is in the case of inelastic demand (Shiferaw et al., 2003). Others show it has a negative influence on household food insecurity perhaps without considering the price effect in the model (Haile et al., 2005). We also expect a negative influence of this variable on food insecurity as we do not consider the price effects because farm households in the study area are not entirely dependent on sell of crop yield as a source of income.

oxen possession (continuous) (Ox)

Literature shows that oxen possession has a negative influence on agricultural production in general as they are important means of tillage and allow producers to sow large area (Sodjinou et al. (2015) and food insecurity in particular (Messay, 2009). The assumption is that households who possess more oxen are less likely to be food insecure than those who possess either less or no ox. In this paper too, we expect that possession of oxen has negative influence on the probability of being food insecure.

Farming system (dummy) (FARMSTM)

Farming system may mean different systems for different authors. For example, for Shiiferaw et al. (2003) it refers to classifying the system based on a combination of crops produced so that they grouped farming system as cereal-based and cereal-enset-based system (Shiiferaw et al., 2003). For others, it refers to the division of farming into shifting cultivation and permanent field farming systems (Beyene et al., 2011). FAO (2001) defines *farming system* as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate (FAO, 2001). It should be noted that a *farm system* refers to a household, its resources, and the resource flows and interactions at this individual farm level so that depending on the scale of the analysis, a farming system can encompass a few dozen or many millions of households. Accordingly, farming systems can be divided into irrigated farming systems, wetland rice based farming systems, rain-fed farming systems in humid areas of high resource potentials, rain-fed farming systems in steep and highland areas and rain-fed farming systems in dry and cold low potential areas, dualistic (mixed large commercial and small holder) farming systems, coastal artisanal fishing, often mixed farming systems, and urban based farming systems (FAO, 2001). In this paper, the definition of farming system refers to whether farming is hoe-based or oxen-based system. It is hypothesizes that households who were based on hoe-farming system were likely to become more food insecure than households who were based on oxen-farming system.

Extravagant consumption (dummy) (EXTRVGC)

This refers to the post-harvest overconsumption of agricultural outputs through different pretexts, the notable ones being traditional festivals, gust hosting, and labor unions mainly by the indigenous people of the study area. We expect to have negative influence on household food insecurity the study area. The assumption is that the more households consume in post-harvest period through different pretexts, the more likely they will be food insecure.

Aspiration for change and wealth (ASPR)

Aspirations (or the capacity to aspire) refer to the manner in which people visualize the future and engage in forward-looking behavior (Frankenberger et al., 2007). This is the capacity of households that conditions the preferences, choices and calculations of individuals/groups as well as the relationships they form with one another (Frankenberger et al., 2007). We hypothesize that aspiration has negative influence on household food insecurity. The assumption is that households who aspire to change their living conditions into better ones will work day and night and become wealthy and food secure and are less likely to be food insecure.

RESULTS AND DISCUSSION

Dietary supply (kcal) of surveyed households

The descriptive statistics of food intake of surveyed households in terms of kcal are presented in Table 1. The study revealed that households had average food intake of 1766.56 kcal/ADE/day with standard deviation (STD) of 1440.06 kcal/ADE/day. Previous studies conducted in central Ethiopia (Shewa), where population density is high and land fragmentation is much more than the *green famine belt*; the average kcal intake was about 4726 kcal/ADE/day (Messay, 2009). Previous study conducted in Bullen district (located in BGR and hence in the *green famine belt*) in Northwestern Ethiopia, showed an

Table 2. Distribution of household food security status by ethno-culture group (N = 220).

Food security status	Type of information	Ethno-culture group		Total (%)
		Indigenous (%)	Non-indigenous (%)	
Food-secure	% within FSS-of -hh	46.8	53.2	100.0
	% within Ethno-culture G.	24.0	33.3	28.2
	% of Total	13.2	15.0	28.2
Food-insecure	% within FSS-of -hh	58.2	41.8	100.0
	% within Ethno-culture G.	76.0	66.7	71.8
	% of Total	41.8	30.0	71.8
Both	% within FSS-of -hh	55.0	45.0	100.0
	% within Ethno-culture G.	100.0	100.0	100.0
	% of Total	55.0	45.0	100.0

average food intake of about 2319.02 kcal/ADE/day (Guyu, 2014). While the former clearly shows that the average food intake is much lower than the non-green areas, the later implies that food insecurity has been worsened in the *green famine belt* as the study was conducted in the same region. There were also differences between the food secure and food insecure groups in their average kcal intakes. As expected, the average food intake was larger for food secure households (3550.2 kcal/ADE/day) than the food secure ones (1066.7 kcal/ADE/day). As with our prior expectation, the average food intake was also larger for non-indigenous group (1994.64 kcal/ADE/day) than the indigenous ones (1579.95 kcal/ADE/day). The study also showed higher diversity in food intakes among household in the food secure group (STD = 1546.5) than in food insecure group (STD = 462.8) and among the non-indigenous group (STD = 1590.82) than the indigenous group (STD = 1280.56). This contrasts to the previous study in Bullen district where the mean kcal intake of households in the indigenous ethno-culture areas (that is, the Gumuz) was higher (1674.16 kcal/ADE/day) than in the non-Gumuz ethno-culture areas (1399.28 kcal/ADE/day) (Guyu, 2014). This shows that severe food shortage is not necessarily the feature of indigenous households.

Food security status of surveyed households

The food security status of households by ethno-culture groups is presented in Table 2. Overall, about 72% of surveyed households were food insecure. This result is very high by standards of some countries in Africa including Ethiopia. For example, in Kwara State, Nigeria 75% of surveyed households was food insecure (Omotesho et al., 2006). Similarly, it is alarmingly larger than the national level incidence of undernourishment indicated in FAO's previous study in Ethiopia that shows 41% in 2005 to 2007 and 28% in 2009/10 (FAO, 2010). It is almost similar with the finding by previous study conducted in Oromiya zone (Wollo) where drought is frequent. Here, about 81 and 74% of households felt food insecure and were food non-sufficient (Degefa, 2005). Likewise, this finding is almost similar with previous study conducted in Arsi zone (Dodota district) in central eastern Ethiopia that showed about 79% of food insecure households (Haile et al., 2005), an area characterized by low rainfall distribution (Haile et al., 2005). Moreover, the finding is much more than that previous study conducted in the central part of Ethiopia (that is, Nonno district in Oromya region), an area characterized by high population density and land fragmentation, which showed about 21% of food insecure households (Messay, 2013). Within the *green famine belt* of Ethiopia (specifically in BGR), previous studies showed smaller proportions of food insecure households than this one. For example, previous study conducted at household level in Bullen district showed about 58% of food secure households (Guyu, 2014). A parallel study that assessed resilience-vulnerability continuum in Belo-jiganfoy district revealed about 65% of food insecure households (Guyu and Muluneh, 2015). The same study revealed that if the moderately food secure households on the continuum were considered as food insecure, the percent of food insecure households would have reached at 80% (Guyu and Muluneh 2015). Out of the total food insecure households, 46.8 and 53.2% were indigenous and non-indigenous ethno-culture groups respectively as compared to 58.2 and 41.8% of food insecure households respectively. Moreover, 24 and 76% of indigenous households were food secure and food insecure respectively as opposed to 33.3 and 66.7% of non-indigenous households respectively. In general, this study shows that food insecurity in our study area (that is, GFB) was at least similar with, otherwise more severe than, that of the drought-prone and high population density areas of Ethiopia. The overall implication of these results is that the depth and severity of food insecurity in the GFB of Ethiopia was severe as in the drought-prone and high population pressure areas. It is more severe for the indigenous households than the non-indigenous

Table 3. Descriptive statistics of the variables included in the model (N = 220).

Variable	Food insecure		Food secure		Both		t-Value
	Mean	STD	Mean	STD	Mean	STD	
HHSZ(ADE)	4.45	1.69	3.55	1.35	4.20	1.65	3.726***
LCULTD(ha)	4.11	2.64	5.52	5.13	4.50	3.57	-2.675***
HEDUY(year)	2.59	3.47	4.26	3.95	3.06	3.68	-3.083***
Livestock (TLU)	1.08	1.99	2.04	3.01	1.35	2.36	-2.779***
AGEHH (year)	39.55	12.61	35.18	11.97	38.32	12.56	2.347**
HEALTH(number)	10.01	9.73	9.00	8.57	9.72	9.41	0.713
AGRPRD (kg/hh)	2310	1620	4630	2682	2962	2232	-7.839***
OX (number)	0.49	1.24	0.73	1.16	0.55	1.217	-1.310
% Responded to given choices for the dummy variables in parentheses							**Chi-sq.**
IRRUSE (*yes*)	6.8		5.5		12.3		4.022**
WEFs ((*yes*)	45.0		14.1		59.1		2.951*
LBRU (*yes*)	50.0		14.5		64.5		6.309**
ETHNCB *(indig.*)	41.8		13.2		55.0		2.360
FARNSTM (*Hoe*)	55.9		14.1		70.0		16.444***
EXTRVGC (*yes)*	43.2		20.0		63.2		2.250
ASPR (*yes*)	31.8		14.1		45.9		0.582

***, *** and * refers to statistically significant at <1, 5 and 10% respectively; Statistical tests used: t-test for continuous and Pearson chi-square for dummy variables.

ones. But, it should be understood that the nature of food insecurity is seasonal in the 'GFB while it is chronic in the non-green famine areas of the country.

Determinants of household food insecurity

Descriptive results of hypothesized variables

Descriptive statistics of hypothesized variables are summarized in Table 3. The mean household size of food insecure households (4.45ADE) was larger than that of food secure households (4.20ADE). The mean difference in the household size between the two groups was statistically highly significant (p<0.01). The negative sign of the t-value shows the inverse relationship between household size and the probability of being food secure. In contrast, the average cultivated land size of food insecure households (4.11 ha) was smaller than that of food secure households (5.52 ha) showing statistically significant mean difference between them (p<0.01) and positive relationship between land size and household's probability of being food secure. The mean year of household head education of the food insecure households (2.59 year) was much lower than that of the food secure households (4.26 years) and the mean difference between the two groups was significant with p<0.01 and positive relationship. Average livestock possession was smaller for food insecure households (1.08 TLU) than for food secure households (2.04 TLU) showing statistically significant difference (p<0.01). In contrast, the average off-farm income was larger for food insecure households (2835.3 birr) than for food secure households (1766.8 birr) showing statistically significant difference at p<0.05. This is indeed because off-farm earning was fundamentally the feature of food insecure household. Similarly, the mean age of food insecure households (39.55 years) was relatively higher than that of food secure households (35.18 years) showing statistically significant differences at p<0.05. The average number of days a household had slept due to sickness (the indicator of the health condition) for food insecure households (10.01 days) was relatively higher than for food secure households (9.00 days) but the mean difference was not statistically significant at p<0.1. The mean aggregate production for food insecure households (2309.5 kg) was much smaller than for food secure households (4630.2 kg) with statistically significant difference at p<0.01. Likewise, the mean number of oxen possessed by food insecure households (0.49) was smaller than the food secure households (0.73) but not significant at p<0.1. About 13% of respondents had access to and used small scale irrigation, with about 7% for food secure and 6% for food secure households. Their mean difference was statistically significant at p<0.05. Almost 59% of households reported their dependence on one or more types of wild foods. Out of this, about 45% were food insecure while 14% were food secure households with statistically significant mean difference at p<0.1. Out of 64.5% of households who engaged in labor unions, 50% belongs to food insecure while 14.5% belongs to food secure households. Their mean

Table 4. Binary regression showing parameters estimating the effects of determinants.

Variable	B	S.E.	Wald	Sig.	Exp(B)
Household size (ADE)	1.528	0.296	26.744***	0.000	4.611
Land cultivated (ha)	-0.120	0.124	0.935	0.334	0.887
Irrigation use (yes/no)	-1.795	0.782	5.268**	0.022	0.166
Household education (year)	-.226	0.076	8.862***	0.003	0.797
Dependence on WEFs (yes/no)	0.915	0.655	1.952	0.162	2.498
Livestock possession (TLU)	0.157	0.150	1.089	0.297	1.169
Participation in labor union (yes/no)	1.205	0.520	5.362**	0.021	3.335
Off-farm income ([a] Eth. birr)	0.005	0.012	0.178	0.678	1.005
Ethno-culture (indigenous/non-indigen.)	0.094	0.765	0.015	0.803	1.098
Age of household Head (year)	0.008	0.020	0.154	0.695	1.008
Health condition (number of days/year)	0.002	0.028	0.006	0.938	1.002
Aggregate production (kg/household)	-0.112	0.022	25.592***	0.000	0.894
Oxen possession (number)	-0.402	0.256	2.473	0.116	0.669
Farming systems (Hoe/oxen-based)	1.410	0.655	4.637**	0.031	4.096
Extravagant consumption (yes/no)	-1.226	0.574	4.571**	0.033	0.293
Aspiration for change and wealth (yes/no)	0.793	0.584	1.845	0.174	2.210
Constant	-1.977	1.222	2.616	0.106	0.138
Model prediction success (%)	Overall case predicted			88.6	
	Food Insecure			93.7	
	Food Secure			75.8	
-2 Log-likelihood ratio for the model			124.049		
H-L model test (df = 8)			Chi-square = 12.341 (p = 0.137)		
Nagelkerke Pseudo R^2			0.668		

***, ** and * represents statistically significant at <1, <5 and <10% respectively. [a] represents US $1 = 19.45 Eth. birr.

difference was significant at p<0.05. Out of 55% of households in the indigenous ethno-culture group contacted during survey, about 42% was food insecure while 13% was food secure, but their mean difference was statistically insignificant at p<0.1. As a whole, 70% of the respondents employed hoe-based farming system, with about 56% food insecure and 14% food secure. Indeed, their mean difference was highly significant (p<0.01).Almost 63% of respondents reported extravagant consumption as a cause of food insecurity. Of this, about 43% belongs to food insecure and 20% belongs to food secure and their mean difference was not statistically significant at p<0.1. Finally, about 46% of respondents reported that they had been aspiring for change and become wealthy. Out of this, almost 43% belongs to food insecure households and 20% belongs to food secure households.

Regression results of determinants influencing household food insecurity

The result of the binary logistic regression revealed that out of 15 hypothesized variables, 7 were statistically most significant at <10% level (Table 4). These include household size, use of small scale irrigation, household head education, participation in labor union, aggregate production, farming system, and extravagant consumption. It does not mean that all the remaining 8 determinants had no influence on food insecurity. Health condition, ethno-culture background and age of household head were the most insignificant factors. Others had moderate effect on household food insecurity. Especially, oxen ownership had moderate influence at almost 10% level (p = 0.116) while aspiration for change and wealth (p=0.174), and dependence on wild foods (p=0.162) were the next moderate influencers at <20% level. Size of cultivated land (p=0.334) and livestock possession (p=0.297) can be regarded to have influenced food insecurity moderately at <35% level.

Model characteristics

The model produced by the binary logistic regression was checked for goodness of fit by using different methods and statistics. In all standards, the model was found appropriate and well fitted the data employed (Table 4). For selection of significant factors, first the regression analysis was run using forward stepwise likelihood ratio (Forward-LR) method. This showed seven significant variables at p<0.10 level. Both the change in -2 Likelihood ratio and Wald statistics were in agreement in showing that each predictor was useful to the model. Moreover, the Omnibus chi-square statistic test was significant. The Hosmer and Lemeshow (H-L) chi-square statistic test for the model was 8.379 (p = 397). Then, as we were interested in those factors which were insignificant at p<0.10, we re-run the binary logistic regression using enter method. We found no difference in the type of significant variables and proceeded with further analysis. The H-L chi-square test statistic as indicated by the enter method was 12.341 (p = 0.137). Both methods were in agreement with each other and showed that the model adequately fitted the data because the p-value of both methods was greater than 0.05 which, as suggested by SPSS, shows a significant model fit. The pseudo R^2 statistic was 0.668 showing that almost 67% of the likelihood of a household being food insecure was strongly explained by the predictors in the model. Moreover, the logistic regression model predicted about 88% of the total variation in the food security status of surveyed households while such predictive capacities were almost 94 and 76% for food insecure and food secure households. The chi-square statistic shows that the parameters included in the model were significantly different from zero at p<0.10 level. This shows that the probability of households' being food insecure was generally related to the predictors in the model so that we can proceed to present and interpret the results.

Effects of demographic factors on household food insecurity

Household size

In line with our prior expectation, the effect of household size on food security was positive (B=1.528) statistically most significant (p<0.01). *Ceteris paribus*, the odds ratio in favor of being food insecure increased by a factor of 4.611 with an increase in the household size by one member. This result conforms to the theory of Malthus (1798) that argues that large population lowers agricultural productivity and food security, but disproves the theory of Boserup (1965) that argues that large family size would increase agricultural productivity through intensification. This is also similar with several previous research findings conducted in developing countries including Ethiopia that showed statistically significant and positive relationship between household size and food insecurity (Shiferaw et al., 2003; Haile et al., 2005; Omotesho et al., 2006; Bogale and Shimelis, 2009; Bashir et al., 2012; Aidoo et al., 2013). The possible explanations to this sort of findings is that in an area where households depend on less productive agricultural land (Bogale and Shimelis, 2009) and/or areas where there is shortage of land or limited access to land and high rate of rural unemployment (Degefa, 2005), increasing household size results in increased demand for food which cannot match with the existing food supply so ultimately ending up with food insecurity. In contrast, the explanation of this finding in our study area (that is, the *green famine* belt) is quite different from the above ones because the situation here is characterized by relatively productive and adequate moisture and is different from the drought-prone and high population pressure areas of Ethiopia. The likely explanation is that many household members would be in their non-productive age and were in capable of contributing their labor. In this regard, the study showed that there were about 97 dependent people per 100 economically active people for the surveyed households. The other possible explanation is that most households reported their dependence on hoe-culture rather than on oxen-plough or other cultivation systems. The survey showed that about 70% of the households depended on hoe-culture which used traditional tool locally known as *sapeta* as main tool for tilling land manually and only 30% of them depended on oxen-culture as main tool for the same purpose. One more justification it that as observation shows that many people in the study area were not hard workers rather prefer to pass much of their working days or hours of days in villages drinking alcohols. In such a condition, an increase in household size obviously affects food insecurity positively.

Age of household head

Contrary to our expectation, the influence of the age of household head on food insecurity was positive but not significant (Table 4). This means that the odds ratio in favor of being food insecure increased by a factor of 1.008 with a one year increase in the age of household head. Although its effect was insignificant, the negative sign goes in line with some studies in developing countries (Bashir et al., 2012; Aidoo et al., 2013). The insignificant effect implies that the mean ages of the food insecure and food secure household heads were almost the same.

Effects of economic, social and cultural factors on household food insecurity

Cultivated land size

Degefa (2005) argues that there should be a positive relationship between access to, and cultivation of land and food security (Degefa, 2005). This argument is proved by many studies in Ethiopia that showed that cultivated land size influences household food insecurity negatively and statistically significantly (Shiferaw, 2003; Bogale and Shimelis, 2009), in Nigeria (Omotesho et al., 2006) and in Ghana (Aidoo et al., 2013). Our study also revealed a negative effect of household food insecurity in line with the general literature, but it was statistically insignificant (P>0.10). This relationship shows that the mean size of cultivated land size possessed by food insecure and food secure households was almost the same.

Livestock possession

Size of livestock possessed by households was insignificant at P<0.10 level in influencing food insecurity. In fact, its effect should not be underestimated as it had 70% probability of influencing food insecurity (p<0.297). The odds ratio in favor of being food insecure increased by a factor of 1.169 with a decrease in livestock size by 1 TLU. However, contrary to our expectation and the general literature (Bogale and Shimelis 2009; Messay 2009), this factor was positively related with food insecurity (B=0.157). The possible explanation for this is that livestock possession was reported by food insecure households and the type of livestock possessed was mostly chicken and small ruminants, which were generally owned by the poor and food insecure households. The better-offs and food secure households, on the other hand, rather possessed oxen. That is why the likelihood of being food insecure for households who had more TUL is was more than those who had less or no TLU.

Aggregate production

This variable is oriented towards the availability component of food security and is the main determinant of household food security/insecurity in rural areas of developing countries (Khan and Gill, 2009). In line with theory and as we expected earlier, the probability of being food insecure was negatively related with (B=-0.112), and significantly affected (p<0.01) by, aggregate production. The odds ratio in favor of being food insecure was increased by a factor of 0.894 with an increase in aggregate production by 1 kg. This is similar with many previous study in developing countries including Ethiopia which showed that per capita aggregate production had negative and statistically significant influence on household's probability of being food security (Shiferaw et al., 2003; Haile et al., 2005). The possible explanation is that households who produced more aggregate production were less likely to be food insecure than those who produced less.

Oxen possession

While the general theory shows that oxen possession is directly related with wealth and food security of households, some argue that it is only one indicator of wealth (Degefa, 2005). The influence of oxen possession of food insecurity was negative (B = -0.402) but statistically insignificant (P>0.10). However, close observation of the probability value (that is, p = 0.116) shows that this variable had almost significant effect on food insecurity at almost 10% level. The odds ratio in favor of the probability of being food insecure decreased by a factor of 0.669 with an increase in one additional ox. This is similar with some studies that showed positive but significant relationship (Haile et al., 2005: Messay, 2009) although our finding shows insignificant result between oxen possession and food insecurity. The likely explanation of this result is clear that households that has one or more oxen can cultivate more food crops and are less likely to be food insecure that households having less or no an ox.

Education

In theory, education and household food security have direct linkages because, mainly in subsistence farming, literate farm household heads are better than their illiterate counterparts in several ways although the role of indigenous knowledge in realizing food security should not be underestimated (Degefa, 2005). Our finding is in line with this theory because it showed that education of household head influenced household food insecurity negatively (B=-0.226) and significantly (p<0.01). The odds ratio in favor of the probability of being food insecure decreased by a factor of 0.797 with one year increase in at school. This indicates that households headed by relatively better educated were less likely to be food insecure than those headed by less educated or illiterate ones. This goes in line with some previous studies in Ethiopia and Pakistan which showed statistically significant and positive relationship between level of household head education and the probability of being food secure (Haile et al., 2005; Bashir et al., 2012). The possible justification is that better educated household heads had better knowledge and skills that enabled them diversify their livelihoods, improve crop productivity, access means of generating income, and easily forecast possible occurrence of food shortages so that they could plan to tackle it.

Off-farm income

The effect of off-farm income on food insecurity was statistically insignificant at p<0.10. Moreover, contrary to our prior expectation and the general literature that shows negative relationship (Omotesho et al., 2006; Bogale and Shimelis, 2009), it was positively related with household food insecurity (B=0.005). The odds ratio in favor of being food insecure was increased by a factor of

1.005 with an increase in such income by 1 Eth. birr. The likely justification of the positive relationship is that it was the food insecure households that mostly reported their engagement in such activities while the statistically insignificant effect implies that food insecure and food secure households had almost the same level of access to these activities.

Participation in labor union

The effect of this variable on household food insecurity was statistically significant ($p<0.05$). However, in contrast to our prior expectation, it was positively related with the probability of being food insecure (B=1.205). The odds ratio in favor of the probability of being food insecure increased by a factor of 3.335 with increased participation in labor union. The likely justification for the violation of the expected relationship between participation in labor union and food insecurity is that households were perhaps engaged in such work to cope with food shortages by earning money and buying grains. This is why the mean off-farm income earned by the food insecure households was much more than that of the food secure households (Table 3). Thus, the frequency of participation in labor union increases as the probability of being food insecure increases as opposed its customary assumption.

Health condition

Health condition of households had insignificant and, as our prior expectation, positive effect on household food insecurity. Despite its insignificant influence on food insecurity, observation of the study area shows that household members were frequently sick of mainly malaria.

Aspiration

Research shows that households that more aspire to become wealthy and desire to change their means of livelihoods are more likely to be self-resilient and food secure than those who do not (Frankenberger et al., 2007). Although aspiration had insignificant effect on food insecurity at $p<0.10$, contrary to our expectation, it had positive influence on the probability of being food insecure (B=0.793). It should be noted that its effect on the household's probability of being food insecure was about 80% (p=0.174). The odds ratio in favor of the probability of being food insecure increased by a factor of 2.210 with increased level of aspiration by one unit. The possible justification for the positive relationship between aspiration and food insecurity is that households were likely to aspire more and more as they becomes more and more food insecure.

Dependence on wild foods: Literature generally shows that wild foods contribute enormously to household food security if they depend on it (Agea et al., 2011; Bharucha and Pretty, 2010; Tilahun and Miruts, 2010). The influences of wild foods (p=0.162) and aspiration (p=0.584) were relatively high. Although insignificant at $p<0.10$ level, the effect of wild foods on household food insecurity was positive, which contrasts our prior expectation and the general literature. Its effect on household probability of being food insecure should not be underestimated as it was almost 85% (p=0.162). The odds ratio in favor of the probability of being food insecure increased by a factor of 2.498 with increased dependence on wild foods. The likely explanation for positive linkage between food insecurity and wild foods is that perhaps household were engaged more and more in wild food gathering and hunting when they become more and more food insecure.

Ethno-culture background

The effect of ethno-culture background on household food insecurity was insignificant at $P<0.10$. Nevertheless, as expected earlier the probability of being food insecurity was more associated with indigenous ethno-culture group as shown by the positive coefficient (B=0.094). The insignificant level of influence shows that the probability of being food insecure was almost the same for indigenous and non-indigenous ethno-culture groups.

Extravagant consumption

As expected earlier, extravagant consumption had negative (B=-1.226) and significant influence on household food insecurity. Also, extravagant consumption influenced the probability of being food insecure significantly ($p<0.05$) in the study area. The odds ratio in favor of the probability of being food insecurity was increased by a factor of 0.293 with a unit decrease in extravagant consumption. The possible explanation is that households that consume more grains with pretext to traditional festivals, labor unions and gusts were more likely to become food insecure than those who did not.

Effects of technological factors on household food insecurity

Irrigation use

The effect of use of small-scale irrigation on household food insecurity was statistically significant ($p<0.05$) and negative (B=-1.795). The odds ratio in favor of the probability of being food insecure decreased by a factor of 0.166 with an increased access to and use of small-scale irrigation by a household. This goes in line with the findings of many previous studied conducted in Ethiopia and showed statistically significant and negative relationships between irrigation use and household food insecurity (Degefa, 2005; Bogale and Shimelis, 2009). The possible explanation is that although there is adequate rainfall in western Ethiopia (*green famine belt)*, access to and use of small-scale irrigation enabled households to produce twice a year. This increased access to both income and food from crop production through irrigation especially during times of crop failures.

Farming system

In line with our prior expectation, the effect of farming system on household food insecurity was positive (B=1.410) and statistically significant (p<0.5). The odds ratio in favor of the probability of being food insecure increased by a factor of 4.096 with increased use of hoe-based farming system. In other words, the probability being food insecure for households who were based on hoe-culture as a farming system was 4.096 times more than those who were based on oxen-culture. The likely justification is that as hoe-based farming system is most traditional system of production, households who depended on it might not produce sufficient crop that could support their members throughout the year. In this regard, many households (mainly indigenous ones) in the study area heavily depended on hoe-based farming system.

Conclusion

This study focused on the determinants of food insecurity in the 'green famine' belt GFB of Ethiopia. The study revealed that household size, use of small-scale irrigation, household education, participation in local labor unions, aggregate production, farming system, and extravagant consumption were found to significantly influence household food insecurity. Households with larger size, did not have access to irrigation, participated in labor union for coping with food shortages, produced more aggregate production, depended on hoe-based farming system, and extravagantly consumed available food were more likely to be food insecure than their counterparts. In contrast to the general literature, the positive linkage between food insecurity and engagement in labor unions shows households' engagement in such activities for earning money and coping with food shortages. Moreover, the influence of cultivated land size, wild foods, livestock in general and oxen possession in particular, and aspiration for change and wealth should be considered as they had moderate effect on food insecurity. Thus, we conclude that factors from demographic, socioeconomic and technological ones determined the food insecurity of households in the study area. Policy interventions may therefore, focus on the most significant determinants while the moderate ones should not be overlooked. Further research interventions should focus on exploring the natural resource bases of the GFB and the trend in the precipitation level so that whether there are drought specks or not in the region.

Conflict of Interests

The authors have not declared any conflict of interests.

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