Level and Determinants of Food Security in North Wollo Zone (Amhara Region – Ethiopia)

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Abstract   This paper examines the Determinants of food security in North Wollo Zone. Primary data from 335 households were collected from 16 kebeles of the zone. We used multistage sampling technique, and questionnaire and FGD were used to collect primary data. Both descriptive and econometric method of analysis were used. For econometric analysis, a logistic regression procedure was employed on household socio-economic cross-sectional data collected in 2016 (April and May). Of the fifteen variables fitted in the model; the age of household head, dependency ratio, average monthly expenditure, non-farm income, family size, distance from input market, farmland size, the number of oxen and livestock ownership were found to be significant. About 42 percent of the sample households were measured to be food insecure. Also, the incidence of food insecurity, food insecurity gap, and severity of food insecurity was 42, 14 and 7 percent respectively. These results have important policy implications for the expansion of non-farm activities and the introduction of livestock stocking programs at the household level to improve the food security status of households.

Keywords: households, food security, logistic regression

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1. Introduction

1.1. Background of the Study

Food safety, physical and economic access to the food needs of human beings, is often associated with food availability, accessibility, and utilization [1]. However, poverty, famine, and low-income stipulations are the root causes of food insecurity in countries located in drought-prone areas of the world. Achieving food security for all people always remains a huge challenge for several developing countries including Ethiopia.

Food insecurity, hunger, and famine had occurred as far back as the beginning of human settlement on the planet earth [2]. Food insecurity has been in the public eye for a long time. Since the biblical story of Joseph at the pharaoh's court predicting seven years of plenty food followed by seven years of famine and stored crop harvests that saved lives at famine years is an early example of food security planning in practice (Genesis 41:27-45). However, food safety began to make a severe impact and became a prominent issue in the development debate in recent history since 1970 [3]. Since then it has rarely been out of panorama. Nevertheless, the current problems are so severe and diverse that millions of people in developing countries are suffering from food shortage and die of its predicaments.

It was argued that the problems of hunger, malnutrition and chronic food insecurity in the last couple of decades remained widespread, not because of insufficient food at the global and national levels, but due to lack of access and redistribution at the household level [4]. Barrett [5] noted that although availability of food has improved noticeably over the past half century, hunger, malnutrition, and food insecurity remain widespread because of poor access and problems of redistribution at the household level. Global agriculture currently produces sufficient calories and nutrients to provide the entire world healthy and productive lives [6]; however, food is not distributed equally among regions, countries, households and individuals [5]. Thus, the problem of food insecurity is primarily a distributional issue a matter of getting available food to people who need it, when they need it, and of ensuring their regular, appropriate, and affordable access to food.

In line with this, Eleni Gebremedhin [7] -explain the issue of the distributional problem in the great famine period of 1983-84 " the northern part of Ethiopia were in acute shortage of food, while there was plenty of food in a southern part of my birth place Ethiopia."

In recent years, there is an indication of reducing poverty and food insecurity in some countries in SSA, but the rate of progress falls far short of the MDG of cutting extreme poverty by half in 2015. This is evident from the fact that the number of people suffering from chronic hunger had increased from 800 million in 1996 to over one billion at the present of which 95% in developing world, 1.7% in industrialized countries and 4.3% countries in transition [8].

According to UNDP [9], SSA is the only region where the numbers of rural people live in extreme poverty is still on the rise through time. The worst affected countries by

famine; hunger and chronic food insecurity include the Democratic Republic of Congo, Burundi, Ethiopia, Malawi, Kenya and Somalia [1]. Therefore, reducing poverty and ensuring household food security by improving livelihoods of the rural poor are critical issues and the challenges for many SSA countries including Ethiopia.

1.2. Statement of the Problem

Ethiopia-the second most populous country in Sub-Saharan Africa-is home to more than 90 million people and it has a tropical monsoon climate characterized by wide topographic-induced variations with rainfall highly erratic [10].

The majority of the population depends on agriculture as the primary source of livelihood, and smallholder agriculture dominates the sector. These small farmers rely on traditional technologies and produce primarily for consumption. Famine vulnerability is high in Ethiopia. With the rapid population growth of the past two decades, per capita, food grain production has declined [11].

Almost one in seven people around the world are chronically hungry, lacking enough food to be healthy and lead active lives. In Ethiopia, two in five households were food energy deficient with little difference between urban and rural areas [11].

Ethiopia is usually at a high risk for droughts as well as intra-seasonal dry spells. Since 1940's five recurrent droughts occurred in Ethiopia and resulted in famine, hunger, food insecurity and death. Most horrible history of famine took place in Ethiopia in periods between 1983 and 1985; the country experienced the worst famine in current history, with a series of rain failures and substantial livestock loss. About 8 million Ethiopians were affected, and one million were estimated to have died [12].

Ethiopia is among the poorest and most food insecure countries of the world. The seriousness of the food shortage problem varies from one area to another depending on the state of the natural resources and the extent of development of these resources. Food insecurity is predominantly chronic in its nature; except particular crisis periods due to recurrent drought. Chronic food insecurity is a condition affecting the population that usually experiences food shortage even when weather and market conditions appear to be good [11].

The food security situation among poor households in North Wollo zone remained to be at Crisis level [13]. This is because the access to these families to their usual food sources (milk, own production, purchase using sale of own livestock) which has been constrained by the drought is not yet normalized

The poor in some woredas' of North Wollo zone, on the other hand, continued facing an Emergency level of food insecurity due to the severe impact of the drought on livestock holding and declined access to income from the sale of cattle, conception, and milk availability [14]. Many studies are conducted in Ethiopia regarding the subject food security with different results vis-a-avis with particular recommendations, and various measures have been taken. However, Ethiopian population is not food secure yet.

The topic gets the attention of different researchers because the problem exists despite plenty of suggestions.

The most recent studies are conducted by Amsalu et'al [15], Zerihun and Getachew [16] and Wali and Penporn [17].

Assefa and Ramakrishna [18] tried to analyze the issue of food insecurity in North Wollo zone. But most important variables, which could affect food security, are missed from their model which would mislead the result. More specifically, they did not include relevant variables like; sex and age of household head, the access to credit, service of agricultural extension workers, the role of non-farm income, and the provision of necessarily improved seeds. As many economic theories explicitly show these variables are at the forefront in determining food security. Therefore, it is important to inculcate all potential factors to decipher food security or insecurity vis-à-vis with the usage of updated information. In this regard, our model is more robust than the previous which will lead to a more accurate result.

Also, the study by Assefa and Ramakrishna [18] is done before 14 years in which the level of food security and the economy as a whole is very different from this time. Many socio-economic factors have been changed in the North Wollo zone and the country too.

Al-in-all, the level of food security and what determines it is not investigated in a proper manner in North Wollo zone. Not surprisingly, this calls an empirical study to be examined and therefore, this study intended to fill this gap by rigorously examining the issue of food security by inculcating many potential factors with all updated information.

1.3. Objective of the Study

1.3.1. General Objective

The primary purpose of this study was to assess the status of food security and its major determinants in the rural households of the North Wollo Zone-Amhara Regional State.

1.3.2. Specific Objectives

In line with the above general goal, the specific aims of the study were to:
- know the implication of off- farm activities on household's food security status
- decipher the impact of access to credit on household's food security achievement
- unravel the relationship between Household size and household's food security
- Identify and evaluate the major factors that affect the status of food security of North Wollo Zone.

1.4. Hypothesis of the Study

The study intended to check, majorly, the following explanation of study:-
- Households engaged in off-farm activities are more likely to experience food self-sufficiency.
- Households with better access to credit are less likely to face food insufficiency compared to those with less access.
- Households with larger size are more prone to food insufficiency.

1.5. Scope and Limitation of the Study

The study was concerned with status, determinants and coping mechanism of food security at household level in North Wollo. Food safety research at the household level is imperative because national and global levels food security analyses can obscure significant differences at the household level. It is different from the community scale in that supports and information are exchanged among members of households more frequently than among households [3].

However, it has also some restrictions. Firstly, this study took a sample of only four Weredas from North Wollo Zone. Secondly, the analysis is made based on the households' estimation of the amount of consumption and livestock and production of crops to determine food security status. Thirdly, the household survey was collected at one-shot (collected only one time). However, rural livelihoods and the factors affecting household food security are dynamic that need to have a longitudinal survey. This was not practiced because of time and financial constraints.

2. Review of Literature

2.1. Situation of Food Security in Ethiopia

Ethiopia is endowed with diverse agro-ecological zones and favorable climate for the growing of a variety of crops and rearing of animals. These endowments contributed to be surplus producer in the pre-1960s and it was a period of self-sufficiency in staple food crops in the history of Ethiopia [19]. The same author also indicated that during the 1960s, annual export had reached on the average 150, 000 tons of grain per year. However, due to natural, human and institutional factors, the agricultural sector failed to meet the food demand of the growing population [20] making food insecurity chronic and pervasive [21]. Consequently, from the 1960s onwards cereal production had decreased on average 4 kg per person per year [19]. The causes of the downward trajectory of the agricultural production are explained by physical, human, socio-economic and institutional factors [22,23]. Alemu et al. [24] for example, reported that availability could be constrained by inappropriate agricultural technologies, unpredictable rainfall and unsound policies. Accessibility to food and its utilization on the other hand, can be restricted by lack of economic growth, too little training, absence job opportunities, poor infrastructure, inadequate knowledge as well as poor governance [25].

Attributed many factors, both natural and humanmade, the country is in food insecurity and hunger since a long time. The country faces drought recurrently and because of that hunger and malnutrition becomes a reality in Ethiopia.

Inability to acquire sufficient food, lack of consistent income and productive assets, inadequate access to health and education services, as well as poor governance at grass root levels, are common indicators of chronic food insecurity in Ethiopia[26,27]. Diminishing farm size and lack of land tenure security are singled out as severe structural constraints challenging the improvement of

household food security [68]. In Ethiopia, all these indicators are prevalent and hence chronic and transitory food insecurity being the root causes of poverty in the country [27]. Devereux [68] indicated that transitory food insecurity is a sudden drop in the ability of the households to purchase and produce enough food. John et al. [28] also stated that food insecurity is a situation when people lack access to sufficient amounts of safe and nutritious food for normal growth and development for active and healthy life. Food insecurity may be caused by unavailability of food, insufficient purchasing power or inappropriate distribution or inadequate use of food at the household level. It severely affects vulnerable groups such as newly established landless households, pastoralists, female-headed households, children and the older adults because of their poor mitigation strategies [29,30]. According to von Braun et al. [27], those who are the hardest hit by transitory food insecurity are the poorest segment of the population.

Ethiopia has been stricken by the continuous occurrences of drought, famine, and hunger, which are the root causes of chronic and transitory food insecurity. The situations initiated the successive governments to formulate rural development policies, strategies, and programs. At present, the population of Ethiopia has reached more than 90 million [31] and about 12 million people are chronically or periodically food insecure [32]. Hence, ensuring household food security needs pragmatic rural policies, strategies, and programs [33]. Perceiving the situations, at the beginning of 2010, MoARD launched the 2010-2014 Food Security Program (FSP) with the aim of improving food security at household level, putting them on a trajectory of asset stabilization and accumulation [34]. The program has four components: i) the Productive Safety Net Program (PSNP) ii) the Household Asset Building Program (HABP) iii) the Complementary Community-based Infrastructure Program (CCI) and iv) the Voluntary Resettlement Program (VRP). Donor financing is allocated to PSNP and HABP capacity building activities, while Government funding to the FSP is assigned to HABP, CCI and VRP [34,35]. Launched in January 2005, the PSNP currently targets about 8 million chronically food insecure rural households. This program is expected to reach 8.3 million households in 320 districts by 2015 in eight regions including Somali region [34]. The objectives of productive safety nets program include the reduction of household vulnerability, the improvement of household and community resilience to shocks and breaking the cycle of dependence on food aid. The key goal is to enable chronically food insecure household to acquire sufficient assets and income to graduate to become food secure [34,36].

Though agriculture is the mainstay of Ethiopians and major driver of existing Economic growth, poverty, in all its manifestations, is still a significant obstacle to overcome. As a result, chronic and acute food insecurity is prevalent. According to Birara et'al [37], "about 10% of Ethiopia's citizens are chronically food insecure, and this figure rises to more than 15% during frequent drought years; 2.7 million People required emergency food assistance in 2014, and 238,761 children require treatment for severe and acute malnutrition in 2014."

The country impeded by many factors to achieve food security and sustainable development. Shishay and Mesay

[38] analyze factors which prevent the country from food safety. Per them production failure, low level of farm technology, illiteracy, high population growth which induces land fragmentation, low availability and engagement to off-farm income generating activities, high rate of degradation, poor health, and sanitation, war and conflict which directly lead to production failure are some of the factors.

2.2. Determinants of Food Security

Several studies have been carried out on the determinants of food security in many different contexts (urban/rural) and levels (regional, national, local) using different variables and methodologies.

Some studies made use of various methodologies to identify determinants of food security in different parts of Ethiopia. Shiferaw *et al.* [39] and Webb *et al.* [40] founds that livestock ownership, farmland size, family labour, farm implements, employment opportunities, market access, level of technology application, level of education, health status, weather conditions, crop disease, rainfall, oxen ownership and family size were identified as major determinants of farm households' food security in Ethiopia.

A study by Haile [41] conducted in Koredegaga Peasant Association, Oromia Zone, identified that farmland size, per capita aggregate production, fertilizer application, household size, ox ownership, and educational attainment of farm household's heads had a significant influence on food security. The computed partial effects at sample mean using results from the logistic regression model indicated that a unit change in farmers' access to fertilizer or educational level of household heads or farmer's access to land or access to family planning improve the probability of food security in the study area.

Another similar study by Ramarkishna *et al.* [18] conducted in North Wollo revealed that per capita land holding, cereal production, livestock, educational level of household heads, fertilizer use and family size were the primary determinants of food security. They constructed food balance sheet, and food security causation was examined using a binary logistic regression model.

The debate in Ethiopia over the causes and determinants of food insecurity has fuelled highly contested viewpoints between the academic disciplines and in development thinking in general over the past few decades, giving rise to a proliferation of demographic, economic, and political emphases across the food security literature [42].

The root causes of the problem at the national, regional, and household level, are quite complex. The key factors, in general, can be grouped under three main types of natural causes, socio-economic factors, and policy factors [18,39]. Demographic characteristics such as the gender, age, and education of the household head were expected to influence food security positively [39]. On the other hand, family size was supposed to have a negative impact on food safety [43]. Since most of the farm households are smallholder subsistence producers, an increase in the number of people in the household tends to exert more pressure on consumption than the labor it contributes.

Ownership of assets such as cultivated land and livestock were expected to affect the food security of the households in this study positively. According to Nejafi

[44] and Muluken [43], food production is increased extensively through expansion of the area under cultivation, while livestock provides not only food for the producers but also other products which could be sold to provide food or income [43].

Fertilizer is used by most studies as a proxy for technology. According to Aliber and Hart [45], subsistence farming by its nature is production for direct consumption. Any farm input that augments agricultural productivity is expected to boost the overall production; this contributes towards attaining household food security [39,69]. In the present study, fertilizer usage was expected to increase household food production and hence enhance food security.

Income plays a key role in a household's accessibility to food. It enables households to modernize their production by giving them an opportunity to buy the necessary inputs and reduce the risk of food shortage during periods of unexpected crop failures through purchases. It was expected the total annual income of the household and food security would be positively related [43].

Access to extension and veterinary services was projected to have a positive impact on household food security in the study area. The availability of credit, another important variable, was expected to influence the household food security status positively. Families who have received credit had the possibility to fulfill their needs for food [46].

A comprehensive study made by Edgar et al. [47] to assess the determinants of household food security in Murehwa District, Zimbabwe by employing logit model have found the following points. The household size, farmland size, farm quality, availability of draught power and climatic adaptation had a significant impact on the food security status of households

On the other side the study conducted by Ometesho et al. [48], have found nonfarm income of the rural households and education have significant effect on the food security status of the rural households, farming households should be assisted to diversify their sources of income so that they may be able to meet their minimum food requirement particularly during the off season

Empirical evidence of food security in Ethiopia indicates the prevalence of a high level of food insecurity. A study made by Misgana [49] on "Assessing rural household food security status and its determinant" by applying binary Logit model found that family size and food safety have a negative relationship. He also found that total cumulative land, full tropical livestock unit and use of chemical fertilizer and total annual income positively affected food security level of the households.

Fekadu and Mequanent [50], found that "Variables related to experiences in farming activities, off-farm and non-farm incomes, land and livestock holdings, as well as soil and water conservation practices significantly affect household food security."

Another study conducted in Nigeria by Muhammad et'al [51] … concludes that Household's monthly income and household head's education positively impacting household food security. On the other hand, household heads' age and family size were negatively associated with household food security.

Wali and Janekarnkij [17] carried out a study to identify determinants of rural household food security in the Jigjiga district of Ethiopia using logistic regression approach and concluded that "total household income, fertilizer use, extension service, access to credit and veterinary service were found to have a positive influence. Access to fertilizer, extension, veterinary and credit would increase household food security in the study area by 84, 46, 36 and 141 percent respectively."

More recently Birara et'al [37] analyse Food Security Situation in Ethiopia and concluded that "Population pressure, drought, shortage of farmland, deterioration of food production capacity, plant and animal disease, frost attack, lack of cash income, poor farming technologies; and pre and post-harvest crop loss are major causes of food insecurity." They further conclude "Sale of wood or charcoal, small-scale trading, institutional and societal income transfer systems, limiting size and frequency of meal were major coping strategies" during food insecurity periods. Most importantly they underline the importance of off-farm income generating activities to boost household's food security status. But their conclusion cannot be taken for granted since they only review previous works instead of doing their investigation which would result in another conclusion.

Oluyole et'al [52] using probit model founds that age, sex, income, and education level of the household have a positive impact on food security whereas as household size have a negative impact on household's food security. In line with this Bogale and Shimelis [33] using binary logit model revealed that age of household head, livestock ownership, credit accessibility, the income of family, and availability of irrigation have a positive impact on food security whereas family size have a negative impact on food safety. Contrary to this Fekadu [53] indicated that age of household has significant negative impact on food safety. In the same way, Fekadu and Mequanent [50] shows that age of household head, household size, and off-farm income availability have negative consequences on food security.

3. Research Methods

3.1. Description of the Survey Area

North Wollo central area is one of the eleven zones of Amara Regional state. It is in the northern part of the country and geographically located at 11°50′N 39°15′E and 11.833°N 39.250°E. It shares a border with South Wollo zone, South Gondar zone, Wag Hamra zone, Tigray Region and Afar Region. In addition to these neighboring areas, part of North Wollo's southern border is defined by the Mille River. The districts of North Wollo zone fall under four livelihood zones. Namewly, Habru, Raya Kobo and the lowland areas of Guba Lafto are in the North Wollo East Plain livelihood zone; Bugna, Lasta and parts of Gidan are under the Northeast Midland mixed cereal livelihood zone; the "Belg" dependent highlands of Guba Lafto, part of Gidan and part of Meket are in the North Wollo Highland Belg livelihood zone; and Woldla and part of Meket—which are known as the Meher-dependent Midland area of North Wollo—fall under the Abay-Tekeze watershed livelihood zone.

North Wollo zone is divided into ten rural districts and two town administrations. The total population of the zone is 217,211, of which 105,697 are males, and 110,514 are females. The rural population of the district accounts for 88.9 % of the total. North Wollo zone covers an area of 472.1 square kilometers, of which 47.3% is degraded, 24% is arable, 17.4% shrub-land, 4.6% pasture, 0.37% forest, and the remaining 6.3% for all other uses. Most of the land in this zone is steep, rugged and mountainous, and unsuitable for agriculture. September is the long rainy season in which most households produce their annual food requirement. The zone is endowed with many perennial springs, rivers, and seasonal streams.

The livelihood of much of the population depends on rain-fed agricultural practices, including both crop production and livestock rearing. Sale of labor, hairdressing, in-house weaving, local alcohol brewing and small trade have all been practiced as a means of income diversification. The households of North Wollo zone are categorized as food insecure, and the average agricultural production of the area is sufficient for only nine months.

Following the worst Ethiopian famines in 1966 (the "Wag-Lasta" famine), 1973, and 1984, the name North Wollo has been intimately linked to starvation. In the past years, all the eight rural districts of the zone have been grouped amongst the most drought-prone and food insecure communities in Amara. These situations have had negative implications for the image of both Amhara and of Ethiopia [14].

3.2. Source of Data

The study employed both primary and secondary data. Primary data was collected through administering a structured questionnaire to rural households in North Wollo Zone. The questionnaire designed to gather qualitative and quantitative data about demographic, resource endowments, farm technology use, attitudinal and other aspects of household's characteristics. The researchers employed data collectors to collect the planned initial information.

Also, secondary sources used to substantiate the analysis and get support for primary data and to analyze the problem at hand in a better way. The sources of secondary data were the following institutions: - Central statistics agency, Ethiopian rural household survey data, international food policy research institute, Amara regional state agricultural office, North Wollo Zone agricultural office, etc.

3.3. Sampling Technique and Sample Size

Three-stage sampling techniques were used to generate the required primary data. At the first stage, Meket, Lasta, Gidan and Bugna *woreda*s were selected purposively from North Wollo zone of the northern part of Ethiopia. In the second stage, kebeles associations have been chosen randomly from each *woreda* based on agro-ecological location sixteen i.e. Gidan from high land, Lasta from semi-tropical, and Meket and Bugna from tropical area of the zone. Finally, a probability proportional to sample size sampling procedure was employed to select 335 sample households.

Before the actual data collection, the emphasis was given to the determination of sample size that is mainly

dependent on the purpose of the study, available resource and precision (variance) required. Often, the sample size is expressed regarding variance. To determine sample size, the study applied a clear formula provided by Yamane [54], statistically estimated at 95% confidence level, the degree of variability = 0.05 and level of precision =90%.

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

Where n is the sample size, N is the population size (total household size), and e is the standard of accuracy. The researcher used central statistical agency's data of Ethiopia, which was collected in 2007 to quantify the sample size of the study.

3.4. Dependent Variable

The dependent variable in this study is Household Food Security (HFS) status. Consumption based rather than an income-based measure of HFS status will be used in this study. This is because consumption will better capture long-run welfare, and it is better in reflecting household's ability to meet their basic needs. Consumption is preferable to measure HFS than income because it is less vulnerable to seasonality and life-cycle, less sensitive to measurement errors and also because of respondents have fewer reasons to lie, it is closer to the utility that people forcefully extract from income, and for the poor most of the income is consumed [55].

Food security will be measured as follows.

Firstly, cereal availability from own production and net transactions will be calculated and used to determine calorie availability for each household -Using conversion factors from IFPRI, quantities of each cereal will be converted into available energy equivalents.

Secondly, the medically recommended levels of calories per adult equivalent will be used to determine calorie demand for each household –that is 2100 kcal per day according to MoFED [56] will be assumed to be the minimum energy demand enabling an adult to lead a healthy and moderately active life.

Thirdly, the difference between calorie availability and calorie demand for households will be used to determine a household's food security status. Households, whose per capita available calories found to be greater than their per capita calorie demand will regard as food secure, while households experiencing a calorie deficit will be regarded as food insecure.

$$\text{HFSi} = \begin{cases} 1, & Yi \geq R(\text{foodsecured}) \\ 0, & Yi < R(\text{foodinsecured}) \end{cases}$$

HFSi = Household food security Status of the ith household, i=1, 2, 3, 4………………335
Yi=Daily per capita calorie available
R=the minimum recommended National standard rate of calories per household per day (2100Kcal).
Severity and Extent of food insecurity

The Three Foster-Greer-Thor beck (FGT) index was used to measure the extent and severity of food insecurity in the study area. FGT index helped to calculate headcount ratio, food insecurity gap and squared food insecurity gap or severity of food insecurity was calculated for the analyses of the incidence, depth, and severity of food insecurity [57].

The FGT model can be expressed as follows

$$P(a) = \left(\frac{1}{n}\right) \sum_{i=1}^{q} \left(\frac{Z - Xi}{Z}\right) a \qquad (1)$$

Where,
n: is the number of sample households
xi: is calorie intake per adult equivalent of the ith household
z: is calorie requirement for i^{th} household
q: is the number of food-insecure households; and
α: is the weight attached to the severity of food insecurity.
In equation 1, z-xi = 0 if xi>z.

Depending on the weight attached to α, Hoddinott [58] identified that giving no weight to the severity of food insecurity is equivalent to assuming that α= 0. In this case, the formula will be reduced to P (0) = q/n, headcount ratio.

$$P(a) = \left(\frac{1}{n}\right) \sum_{i=1}^{q} \left(\frac{Z - Xi}{Z}\right) 0 = \frac{q}{n}. \qquad (2)$$

Here, Headcount ratio was calculated to measures the incidence of food insecurity or the proportion of households defined to be food insecure. It does not indicate the depth of food insecurity. It does not also tell us whether the food insecure households are only slightly below the subsistence requirement level or whether their consumption falls substantially short of subsistence level.

Giving equal weight to the severity of food insecurity among all food insecure households is equivalent to if α = 1. Summing the numerator gives the food insecurity gap and dividing this by z expresses the figure as a ratio/index and results in the following expression for food insecurity gap,

$$P(a) = \left(\frac{1}{n}\right) \sum_{i=1}^{q} \left(\frac{Z - Xi}{Z}\right) 1. \qquad (3)$$

Food insecurity gap was calculated to know how far the food insecure households are below the recommended daily caloric requirement and provides the possibility to estimate resources required to eliminate food insecurity through proper targeting [57]. This measure fails to explain the inequalities within the food insecure household groups which call for the need for square food insecurity gap measurement.

Giving more weight to the severity of food insecurity among the most food insecure households is equivalent to if α >1. A standard approach in the poverty index is to set α = 2, yielding the severely food insecure groups among the food insecure groups [58].

$$P(a) = \left(\frac{1}{n}\right) \sum_{i=1}^{q} \left(\frac{Z - Xi}{Z}\right) 2. \qquad (4)$$

The squared food insecurity gap that measures the severity of food insecurity among the food insecure households or that measures the squared proportional shortfalls from the minimum level was calculated to

address the most food insecure segment of the sample household.

3.5. Explanatory Variables

A decision on the variables to be included in the analysis is the first step in constructing a model for a specific purpose or a particular sector of an economy. In doing so, it is usually important to take into account what economic theory has to say about the relations between the variables of interest; unfortunately, economic theory is not often rich enough to provide a dynamic specification that identifies all of these relationships.

Based on the reviewed literature, some of the common predictors that are expected to influence rural household's food security in the study area are the following.

1. **Age of head of household (AGE)**: Age is a continuous explanatory variable. As the age of a family increases, it is assumed that farmers could acquire more knowledge and experience [59,60]. Thus, it is hypothesized that age of the household heads and food security are positively correlated.
2. **Sex of head of the family (GEND):** It is implied as one if the head was male and 0 otherwise. Compared to male headed households, female-headed households are more exposed to the risk of food insecurity because of their limited access to livelihood assets [17,61]. Thus, a Male household headed and food security will have a positive relationship.
3. **Household family size (HHFS)**: This refers to the total number of persons living in a household. As the number of household increases the families to be food secure will decrease [49,62]. Therefore, large family size will have a negative relationship with food security.
4. **Dependency Ratio (DR):** Dependency ratio is obtained by dividing inactive labor force (age less than 15 and above 65) by the active labor force (age between 15 and 65) within a household. A household with more inactive productive labor force compared to the current period shows a high dependency ratio, and it is more likely to be food insecure [50,59]. Therefore, it is hypothesized that dependency ratio and food security are negatively related.
5. **The education level of head of household (EDU):** Education is a key for improvement of rural livelihood in general and household food security in particular. Thus, in the study likelihood of food insecurity is increased among households headed by illiterate heads than literate ones [2,63,64].
6. **Average Monthly Expenditure (EXPEND)**: This continues variable which measures household average monthly expenditure on consumption goods. When household expenditure is high on consumption averagely in a month, this shows household's higher income level [24,49]. Thus, it is hypothesized expenditure of the household and food security has a positive relationship.
7. **Farm Land Size owned by Household (FLS)**: This is the amount of land household owned in a hectare. That household with large land size can produce many and diversified agricultural products [15,17]. Thus, it expected that as farm land size and food security have a positive relationship.
8. **A total number of livestock (excluding oxen)**: It is a continuous variable and measured in TLU (Tropical Livestock Unit). Households with large livestock size are expected to be less vulnerable to food insecurity especially in times of drought when crops fail to yield [50,61]. Therefore, ownership of large size of livestock increases the likelihood of the household to be food secure.
9. **A number of oxen owned (OXEN)**: Ox is critical input in North Wollo to cultivate the agricultural land. Having many Oxen for a farmer means they can plough their land without difficulties and involved in the loan [2,61,62]. It is expected that number of Oxen household own, and food security has positive relationship.
10. **Use of improved seed (SEED)**: It is a dummy variable taking 1, if the household has access to improved seed 0, otherwise. When a household has access to improved seed household can increases there production and will be less vulnerable to disasters [24,50,60]. The expected sign of using improved seed and food security is positive.
11. **Access to credit service (CREDIT):** Credit service is one of the essential elements that contribute to sustainable rural development; because it enables households to diversify their livelihood and ensure their food security [60,63] It is a dummy variable taking the value 1 if the household receives credit 0 otherwise. Thus, a household which has access to credit does initiate investment in farm and non-farm activities and achieve food security. Thus, it is hypothesized that a household which has access to credit is more likely to be food secure.
12. **Distance from Input Source (DIST):** This is the distance between household living area and the place where a household can get a necessary input for their production and consumption. This will be measured by kilometer. Near to input source means small expense for transportation and can sell their product quickly [38,44]. Thus, distance from input market and food security will have a negative relationship.
13. **Access to agricultural extension service (AGREXT)**: This is institutional service provided by the government to households. It takes dummy values 1, if the household has access to agricultural service, 0 otherwise. Agricultural extension service can increase household's awareness to use improved seed, intercrop plantation, using drought-resistant crop and using irrigation [2,24]. Therefore, the participation of agricultural extension service and food security have a positive relationship.
14. **Fertilizer application (FER)**: It is dummy variable which assumes 1, is household uses fertilizer, 0 otherwise. Using fertilizer kill pests and insects which will reduce production level of the household [63,65]. Thus, it is expected that fertilizer application and food security will have a positive sign.
15. **Non-farm income (NFI)**: This is income obtained from non-farm activities. This will help the

household to diversify livelihood [29,66]; Adene, 2008. Hence, it is expected that the availability of off-farm/non-farm income is positively associated with household food security.

3.6. Method of Analysis

Before analysis, the collected data was entered the computer and cleaned. The data then was analyzed using both descriptive statistics and econometric analysis.

Descriptive statistics like means or averages, ratios, frequency distributions, percentages, standard deviations along with the minimum and maximum were used in analyzing the socio-economic characteristics of the farmers, input and output variables and problems encountered by food secured farmers in the study area.

Food security was estimated using computer software STATA 14 program. Hence, in this study, the computer program was used to assess the logit model and odd ratio effect results of the food security model.

3.7. Model Selection

A limitation of ordinary linear models is the requirement that the dependent variable is numerical rather than categorical. However, many interesting variables are categorical-patients may live or die, people may pass or fail exams, households may be food secure or insecure and so on. A range of techniques has been developed for analyzing data with categorical dependent variables, including discriminate analysis, probit analysis, log-linear regression and logistic regression.

Logistic regression was used to predict a response variable based on continuous, discrete, dichotomous, or a mix of any of these predictor variables. Logistic regression enables to determine the percent of the variance in the response variable explained by the predictor variables; to rank the relative importance of predictor variables; to assess interaction effects, and to understand the impact of covariate control variables.

The logistic model has powerful predictive power. Its close relationship to the log-linear analysis of contingency table and linear discriminate function analysis made the logistic model more traditional than the other related models. In most cases, logistic regression serves as a standard to which other models are compared.

Logistic model, as compared to its competitor, the probit model, is less sensitive to outliers and easy to correct a bias [67]. In instances where the independent variables are a categorical or a mix of continuous and categorical, logistic is preferred to discriminant analysis. The assumptions required for statistical tests in logistic regression are far less restrictive than those for ordinary least squares regression are. There is no formal requirement for multivariate normality, homoscedasticity, or linearity of the independent variables within each category of the response variable. However, the following assumptions still apply to the logistic regression model. These include meaningful coding, the inclusion of all relevant and exclusion of all irrelevant variables in the regression model, little error in the explanatory variables, linearity in logits, independent sampling, no outliers, no

multi-collinearity and sampling adequacy. Regarding such pre-testing mechanisms, the researcher will employ appropriate tools in the actual conduct of the investigator.

The study used the logit model in line with earlier researchers and the reasons above. Following Bogale [33], the cumulative logistic probability model can be econometrically stated as

$$P_i = F(Z_i) = \frac{1}{1 + e^{-(\alpha + \sum \beta |X|)}} \quad (5)$$

Where P_i = the probability that an individual is food secure given Xi
X_i= a vector of explanatory variables
α And β = regression parameters to be estimated.
e= the base of the natural logarithm

For ease of interpretation of the coefficients, a logistic model could be written regarding the odds and log of odd. The odds ratio is the ratios of the probability that a household would be food secure (Pi) to the likelihood of a household not being food secure (1- Pi). That is:

$$\frac{P_i}{1 - P_i} = e^{Z_i}. \quad (6)$$

Taking the natural logarithm of the equation yields

$$Ln(\frac{P_i}{1 - P_i}) = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots\dots + \beta_m X_m \quad (7)$$

if the error term included the equation becomes

$$Ln(\frac{P_i}{1 - P_i}) = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots\dots + \beta_m X_m + e_t. \quad (8)$$

4. Data Analysis and Discussion

4.1. Household Demographic and Socio-Economic Characteristics of Sample households

4.1.1. Sex and Marital Status

The total Household members of the sampled households were 335 of which 296 were males and 39 females. As far as sex ratio of the household members is concerned, males are greater in number. The number of food insecure female household is higher in proportion than male. Among 142 food insecure household 20 of them were women family headed which is 14.08 percent.

Regarding their marital status, about 88.06 % of sample households were married while 7.16, 3.58% and 1.19 % were single, divorced and widowed respectively. From secure food households, 90.16% were male-headed, and 9.84% were female-headed. Similarly, within food, insecure households 85.92% and 14.08 % were male and female-headed respectively from Table 1.

There was insignificant variation in the marital status of the sample household heads between single food insecure household headed and secured household headed with 9.57 percent. Married food secured household headed is greater than married food insecure household headed with a percent of 91.71 and 83.10 respectively (Table 1).

Table 1. Sex and Marital Status of the respondents

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
N	%	N	%	N	%
Sex of the Household Head					
Male	174	90.16	122	85.92	296	88.36
Female	19	9.84	20	14.08	39	11.64
Total	193	100	142	100	335	100
Marital Status of households					
Married	117	91.71	188	83.10	295	88.06
Single	6	3.11	18	12.68	24	7.16
Divorced	6	3.11	6	4.23	12	3.58
Widowed	4	2.07	0	0	4	1.19
Total	193	100	142	100	335	100

Source: Survey result, 2016.

4.1.2. Age, Education, Household size and Dependency Ratio

From the following chart the mean age of the sample household heads was found 43.46 with a standard deviation of 10.10. The maximum age observed was 75 while the minimum was 20 years. The mean age of food insecure households was 42.33 years, and that of secure food households was 44.29 years. The statistical analysis revealed that there is no significant difference in the mean age of the household head between food secure and food insecure households.

Table 2. Age, Education, Household size and Dependency ratio of the Respondents

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Age	44.29	10.10	42.33	11.25	43.46	10.63
Household Size	5.20	1.69	4.76	1.77	5.01	1.74
Educational Level	3.02	2.95	2.38	2.74	2.75	2.88
Dependency Ratio	1.02	0.683	0.98	0.72	1.008	0.69

Source: Survey result, 2016.

Based on the above table the maximum and the minimum household size were 11 and one respectively. The mean household sizes for food secured households were 5.2 while for food insecure were 4.76. The average household size for the surveyed households was 5.01 with a standard deviation of 1.74. Based on the survey 35.5 percent of the respondents were illiterate while 64.4 percent can read and write. Food secured household have better access to education than food insecure households.

Dependency ratio defined as the proportion of people aged in between 0 to 14 and above 64 over those aged in between 15 to 64. The survey result indicated one average dependency ratios for the total sampled households. However, the study result shows that similar to the age of

household head, dependency ratio has no significant mean difference between food insecure and food secured households, which is 0.98 and 1.01 respectively (Table 2).

4.1.3. Land size, Ox and Tropical Livestock Unit (TLU)

Livestock is the second most asset for households living next to land in the study area. The survey result signifies that 11.34% of the sample households do not have livestock while the majority (88.65 %) of sample households were found having different types of livestock consisting of goat, sheep, camel, cattle, back animals (camel and donkey) and poultry with a typical household maintained an average of 2.02 TLU. In the study area, an average livestock holding, excluding ox is 2.02 Tropical Livestock Unit (TLU) and the minimum and a maximum number of livestock holds were 0 and 10.02 TLU respectively.

The survey result shows that food secure households possessed a relatively high number of livestock than food insecure households and the mean difference between the two groups due to owning of livestock. Seven percent of food secured households and fourteen percent of food insecure households have not livestock. 87 per cent of households have livestock.

Table 3. Livestock, Ox and Land size of the respondents

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Livestock	2.4	2.07	1.38	1.44	2.02	1.91
Ox	1.21	0.97	0.84	0.94	1.05	0.98
Land size	0.53	0.60	0.38	0.38	0.47	0.52

Source: Survey result, 2016.

From the above table in the study area, households owned on average 1.05 oxen. About 35 percent of respondents have no oxen. At the same time, 44 percent of food insecure households and 27 percent of food secured households have no oxen. This implies food insecure households are found with a shortage of oxen. The average landholding size of the study area is 0.47 hectare with standard deviation (0.52), while the average land holding size for food secured and insecure households are 0.53 and 0.38 hectare respectively. Almost 13 percent of the respondents have no access to land. About 83 percent of the interviewees believes as their land is scarce to undertake agricultural activities while 17 percent of believing as the land is sufficient in amount for agricultural production. The maximum amount of land in the study area was 4 hectares.

4.1.4. Access to Improved Seed, Fertilizer, Extension and Credit Services

Access to Improved Seed, Fertilizer, Extension and Credit Services to sampled households, which are important to explain the food security status of households discussed as follow.

Table 4. Improved Seed, Fertilizer, Extension and Credit Access

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
N	%	N	%	N	%
Did you use improved seed in the last year production?					
Yes	125	64.77	94	66.2	216	65.37
No	68	35.33	48	33.8	116	34.63
Did you use fertilizer in the last year production?					
Yes	96	49.74	77	54.23	173	51.64
No	97	50.26	65	45.77	162	48.36
Did you have access to Extension services?					
Yes	185	95.85	134	94.37	319	95.22
No	8	4.15	8	5.63	16	4.78
Did you borrow any money from lending institutions during the last 12 months?					
Yes	90	46.63	67	47.18	157	46.87
No	103	53.37	75	52.82	178	53.13

Source: Survey result, 2016.

Based on the above table on average the 65 percent of sample household have access to improved seed while 35 percent have not. The food secured households have better access to improved seed than food insecure households. In the case of fertilizer application of farmers on their farm most farm household did not use fertilizer. Food insecure household usage of fertilizer is low as compared to secured households with 54 percent and 46 percent.

95 percent of sample households have access to extension service while 5 percent of households have no access extension services. The types of information sample households obtained from extension workers are about Fattening animals, Harvesting, modern ploughing, Education, crop production, Protecting crime, using of inputs, natural resource conservation, bookkeeping, weaving, iron melting, sale of water, cloth decor, tea and bread trading, teacher and sale of beverage. The primary sources of market information for household were extension workers, societies, trade, radio, and mobiles.

From our sample respondents' 48.87 percent of household have credit access and 53.13 percent of households have no credit access. There is no significant difference between food secured and insecure households who had credit access with percentage of 46.63 and 47.18 percent. The sources of credit for sample respondents were 88.02 from MFI, 5.39 from idir, 3.99 from eqib and from 2.09 NGOs. On the other side household's unwillingness to participate in microfinance was due to high interest, uninterested to take loan, lack of collateral and religion were main reasons. From Focus group discussion information, to get loan from ACSI farmers forced to prepare business plan. Commonly, the plan was made by extension employee which copied for most farmers and accepting farmers this only to get the loan because this is the only option to obtain money from ACSI.

4.1.5. Distance of Market, Main Road and Health Center

In this section the sample household access to infrastructure of road and health services will be discussed using time. The mean distances for respondent were four hour and thirty-five minutes. Food insecure household went long distance as compared to food secured households. Eighty-five percent of the households obtained agricultural inputs from furthest market or woreda's market. On the other side the time taking for main road on average takes one hour and twenty-two minutes. The maximum period for main road is two hours.

Table 5. Distance of Market, main road and Health Center

Food Security Status					
Food secured (193)		Insecure (142)		Total (335)	
Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Distance from market center	4.17	5.33	4.6	9.01	4.35	7.11
Distance from Main road	1.29	1.11	1.12	1.6	1.22	1.34
Distance from Health center	1.15	3.01	0.89	0.90	1.04	2.36

Source: Survey result, 2016.

Based on the above table on average the health service takes one hour and four minutes. The minimum and maximum time for health service are two minutes and fifteen hours. 99.4 percent of the respondents have access to health services.

4.1.6. Occupation, Saving, and Crop Failure

97.91 per cent of respondent's occupation was a farmer. In addition to farm especially food secured household participate in trade. Food insecure household main occupations were a farmer, student, and housewife. On average the in the household one person had a job. The maximum and minimum numbers of household numbers got employment were 6 and zero.

Table 6. Occupation, saving and crop failure status of the respondents

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
N	%	N	%	N	%
What is the occupation of the household head?					
Farmer	188	97.41	140	98.59	328	97.91
Others	5	2.6	2	1.4	7	2.1
Did you experience crop failure due to a shortage of rainfall?					
Yes	163	84.45	134	94.36	298	88.96
No	30	15.54	8	5.64	37	11.04
Did you save some amount of money (grain) to use in case of emergency?					
Yes	137	70.98	88	61.97	225	67.16
No	56	29.02	54	38.03	110	32.84

Source: Survey result, 2016.

As it is known since the study is vulnerable to drought and famine, 89 percent of the respondents faced crop failure due to a mainly shortage of rain. Relatively food insecure households had much crop failure. The main rainfall deficit years within these ten years were 2000, 2005 and 2007. The saving habit of the food secured households was better than food insecure households. On average 67 percent of the respondent save money or grain in the case of emergency (Table 6).

4.1.7. Remittance and Non-Farm Income Activities

Non-farm income is farmers get income out of agricultural activities. On average the survey result confirms that the percentage of households engaged in nonfarming by secure food households was higher than food insecure ones. Fifty-seven percent of stated that they were involved in non-farming activities. Female household headed to participate in non-farm activities than male-headed.

Table 7. Remittance and Non-Farm Income Activities of the respondents

Food Security Status					
Food secured (193)		Food Insecure (142)		Total (335)	
N	%	N	%	N	%
Have you received remittance from someone living elsewhere during the last 12 months?					
Yes	41	21.24	11	7.75	52	15.52
No	152	78.76	131	92.25	283	84.52
Did you or your household member participate in non- agricultural income generating activities?					
Yes	110	56.99	70	49.29	190	56.71
No	83	43.01	72	50.71	145	43.28

Source: Survey result, 2016.

Employment and income earning opportunities available in the area were only own farm employment, farm laborer, non-farm laborer, aid and work in cities from top to down. The top five activities they have been participating were livestock trading, daily working, participate in building work, petty trading and preparation of local drinks which could be suggested as that of alternative areas of intervention to diversify their livelihood sources. Households mainly utilize the income they generated from non-farm activities to buy food, to buy clothes, for saving, to pay tax and to pay loan respectively.

From above table food, secured households got financial support from their families living elsewhere. The remittance of food secured (21.52%) was higher than the average household remittance (15%) and food insecure remittance (7.75%).

4.1.8. Major Crops Consumed in the Study Area

Respondents were asked about their main food items for consumption and before four weeks and relevant sources to afford these things. Accordingly, Main food elements that are consumed in the study area were wheat (48.75%); sorghum (15.62%), Teff (11.25%), maize (10.12) and Haricot Bean (8.75%) currently. But before four weeks the main food items consumed by the respondents were wheat (48.06%), Teff (17.05%), Sorghum (12.40%), Haricot bean (10.10%), maize (5.42%) and sweet potato (4.49 %).

Table 8. Major Crops Consumed by Respondents

Main food items	Frequency current	Rate before past four weeks	Percentage Currently	Percentage Before past four weeks
Maize	81	35	10.12	5.42
Haricot bean	70	65	8.75	10.10
Teff	90	110	11.25	17.05
Wheat	390	310	48.75	48.06
Sorghum	125	80	15.62	12.40
Sweet potato	15	29	1.87	4.49
Barely	29	16	3.62	2.48
Total	800	645	100	100

Source: Survey result, 2016.

Based on the above table the main food items in the study area were wheat, teff, and sorghum respectively. The result is almost consistent with the data we obtained from North Wollo Agricultural office, as Teff, Wheat, barley, sorghum, and Maize respectively.

As it shown in table, the current consumption primary sources of food items were own production (52.67%), free relief food (26.82%), and food for work safety net transfer (5.83%). When the household attained their current consumption items through buying their main sources were sales of livestock, selling woods, safety net cash transfer, sales of livestock products and petty trading.

4.1.9. Self-Assessment of the Household about Their Food Security Status

When we assessed the households about their food security status, the household's response were different from what we obtained from Kilo Calorie approach. On average 64.48 percent, 13.43 percent, and 22.1 percent of the respondents believed as they were food insecure, secured and one time secured and another time insecure. This is because of the current drought household hides some important information regarding with their consumption and production pattern due to not be excluded from aid and safety net cash transfer which was delivered by government and NGOs as we get from focus group discussion.

Table 9. Sources of Main Food Items

Sources of Main food items	Frequency of currently consumed items	Rate of before four weeks consumed Items	Percentage of Now consumed Items	Percentage of before past four weeks consumed items
Own production	966	329	52.67	28.38
Borrowed	33	58	1.78	5.00
Bought	80	104	4.36	8.97
Food for work Safety net transfer	107	60	5.83	5.17
Free relief food	492	500	26.82	43.14
Gift	100	49	5.45	4.22
Aid	56	59	3.05	5.09
Total	1834	1159	100	100

Source: Survey result, 2016.

Table 10. Household self-assessment about their food security Status

	Food secured (193)		Food Insecure (142)		Total (335)	
Food Security Status						
	N	%	N	%	N	%
Do you meet the all-year-round food requirements of your household members from own production?						
Yes	37	19.17	14	9.86	51	15.22
No	156	80.83	128	90.14	284	84.78
According to your self-assessment is your household						
Food Secured	33	17.10	12	8.45	45	13.43
Food Insecured	107	55.44	109	76.76	216	64.48
Varies from one year to another year	53	27.46	21	14.79	74	22.09
Did the income you earn from non- farm activities enable you to buy food for bridging the food gap?						
Yes	83	43.01	48	33.80	131	39.10
No	110	56.99	94	66.20	204	60.90

Source: Survey result, 2016.

From above table on average 85 of the respondents assumed as they couldn't meet their yearly consumption by their production. Beyond this 90 percent of food, the insecure household was believed as failed to respond their yearly consumption by their production while 81 percent of food secured household found as failed to respond their annual consumption by their output. Here 43 percent of food secured household covered the food shortage by engaging in non-agricultural activities greater than by 10 percent as compared to food insecure households. On average, almost 40 percent of households tried to cover their food shortage participating through non-farm activities.

Children, old people, disable people, female-headed households and children losing their families with HIV/AIDS were most vulnerable to food insecurity. The main causes of food insecurity were bad weather condition, labor shortage, meager income from non-farm activities, inability to produce sufficient grains and to rear livestock, lack of fair market for selling and purchasing, do not using modern inputs and agricultural technologies, failure to properly utilize own production and other earnings and instability due to frequent changes in rural policies.

4.1.10. Monthly and Yearly Expenditure of Households

Some months on average households cover their consumption requirement through production were seven months. The rest five months covered by free life, safety net transfer, and non-farm activities. There were two months' gap between food secured and insecure households in fulfilling their consumption requirements through production (Table 11).

The monthly expenditure of food secured households was higher than food insecure households. The average monthly expenditure of the sample household was 1483 birr which is greater than 559 birr as compared to food insecure households, and lower than by 273 birrs as compared to food secured households. Like monthly expenditure, the yearly monthly cost of food secured household was higher than food insecure households and average monthly expenditure of households (Table 11).

Table 11. Monthly and Yearly Expenditure of Households

	Food secured (193)		Insecure (142)		Total (335)	
Food Security Status						
Mean		Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Number of Months production cover household's food requirement	7.9	2.6	6.4	2.4	7.2	2.6
Monthly expenditure	1720	2337	1161	1774	1483	2132
Yearly expenditure	14719	28296	9225	7973	12814	22182

Source: Survey result, 2016.

4.3. The Household Food Security Status of Sampled Households

The amount of energy available for the household is compared with the minimum subsistence requirement per AE per day (i.e. 2,100 kcal). Household dietary quantity was measured by daily calorie availability per adult equivalent (kilocalorie, kcal). Kilocalorie per adult equivalent (AE) is calculated by dividing the consumed food by household size after converting it into kilocalorie. Accordingly, the percentages of food insecure and secure households were found to be 42% and 58% respectively.

The survey indicates that the mean value of the energy available for food insecure and secure households was 1,081 Kcal/AE/day and 2,893 Kcal/AE/day, respectively. The minimum and maximum energy available for food insecure households was 942 Kcal and 2,650 Kcal, respectively. Whereas the minimum and maximum energy intakes of secure food households were 2,203 Kcal and 3,492 Kcal, respectively. The mean energy intake of all sample households was 2,124 kcal. The level of food insecurity increased by 2 percent as it was studied by Ramakrishna & Demeke [16] before 14 years based on Amhara Regional Bureau data.

Table 12. Household Food Security Status

Food secured (57.61%)		Food Insecured (42.39%)		Total (100%)	
Food Security Status					
Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
2893	1863	1081	1061.3	2142	1928

Source: Survey result, 2016.

When we compare the result of North Wollo Agricultural Office, the Bureau recorded as there are 335386 (Three hounded fifty-three thousand three hundred eighty-six people) out of 1568353 (One million five hundred sixty-eight thousand three hundred fifty-three people) food

insecure population in the form of temporary and permanent direct support program. The public work or temporary direct support consists 283461 people where the Permanent direct aid program comprises 51925 people out of 1568353 zonal people. The above data confirmed as the level of food insecure people is 21.4 percent at the zone level. But if we calculate the level of food insecure people in our sample woreda it increases to 26 percent.

4.2.1. Extent and Severity of Food Insecurity

The result revealed that the incidence of household food insecurity was 0.42. This implies that about 42 percent of the sampled households were not able to meet the daily recommended caloric requirement which is 2100 kcal per day per adult equivalency. The result is consistent with the research result of Amsalu, [13]. This also supported the food balance sheet approach based on adult equivalent.

The calculated value for food insecurity gap was 14 percent. This showed food insecure Households were 14.2 percent far off from the minimum level of calorie requirement which also implied 14.2 percent of the caloric need of every food insecure households was required to bring up to the recommended daily caloric requirement level, which was lower than the study made by Tilaye (2004) and Amsalu, [13]. In addition to food insecurity gap and headcount ratio, the severity of food insecurity households was 0.0715. This implies about 7.15 percent of households are the most food insecure groups of households in the study area.

Table 13. Household incidence and severity to food insecurity

Measures of Food insecurity	Percent
Incidence food insecurity (Headcount ratio)	42.00
Depth food insecurity (Food insecurity gap)	14.21
Severity food insecurity (Squared food insecurity gap)	7.15

Source, own survey, 2016.

4.3. Determinants of Household Food Security

Based on the result of the multicollinearity diagnostics test for both continuous and dummy explanatory variables, no variable was found to be highly correlated or associated with one or more of other variables. Logistic regression model was used to identify determinants of food security. Accordingly, variables assumed to have an influence on household food security in different contexts were tested in the model and out of 15 variables nine of them were found to be significant. Among variables fitted into the model age of household, dependency ratio, average monthly expenditure, distance from input market, non-farm income, household size, farmland size, the number of oxen and livestock ownership were found to be significant in determining household food security.

The logistic regression was conducted using STATA 14 with 335 number of observation. As chi2 revealed, the overall significance of the model is useful based on the probability of less than one percent. The logistic model table confirms the age of the household head has positive and significant (at p < 1 %) relationship with household food security. The logit increases by a factor of 0.28 as the

age of a household head increases by one year keeping the other variables constant. The result is consistent with Girma, [43]; Fisher and Lewin, [44] research. As age increases, one can acquire more knowledge and experience becoming active in exploiting these experiences. The sign of the variable was like earlier expectation.

Logistic regression

Number of obs	= 335
LR chi2(15)	= 41.85
Prob > chi2	= 0.0002
Log likelihood	= -207.38044
Pseudo R2	= 0.0917

Table 14. Logistic model output with log-odd ratio

Predictor Variables	Odd ratio	Estimated coefficient	Standard error	Significant level
Age	0.286	1.253	0.517	0.015
Sex	1.00	0.007	0.013	0.580
Household Size	1.348	-0.299	0.084	0.000
Dependency Ratio	0.013	-3.256	1.53	0.039
Education	1.081	0.084	0.050	0.069
Land size	1.273	0.241	0.357	0.021
Monthly Expenditure	0.666	0.407	0.166	0.019
TLU	0.001	8.045	2.686	0.002
Ox	1.282	0.247	0.150	0.047
Seed	1.066	0.062	0.290	0.813
Credit	1.189	0.184	0.313	0.512
Distance from market	1.385	-0.326	0.194	0.045
Extension	1.304	0.271	0.724	0.632
Fertilizer	1.019833	0.020	0.286	0.944
NFI	1.06	1.623	0.890	0.049
Constant	0.000	-6.802	0.001	0.002

Source Household Survey, 2016.

Household size affects food security situation negatively and significantly at 5 % probability level. The negative relationship indicates that smaller households are less food insecure than larger households. This implies that, as family size increases by one person, the likely probability to become secure food decreases by a factor of 1.35. Increases in family size, whose members are more of inactive labor force enhances the number of dependent family members and reduce the availability of enough food for a household. The possible explanation is that households with larger family are vulnerable to food insecurity. As the sizes of the households are increasing the consumption expenditure increases. The expenditure is from consumable goods, school fee, farm, fertilizer and laborer for farm activities. Since the area is vulnerable to drought and famine more family leads to high food insecurity. This result is consistent with the finding of Idirsa et al. [45] and Misgana, [37].

The result also showed as there is a positive relationship between land sizes of the household food security status of the household. The odd ratio implies as the land sizes of the household increases by one hectare the probability of a

household being food security increases by 1.273. The result is the same with Wali and Penporn, [15], and Amsalu et al., [13]. Since the majority of the household are agrarian land is everything for them. An increase in land means household will have a probability to produce more foods which helped them to be food secured.

The dependency ratio of the household was negatively correlated with household food security. The odds ratio for food insecurity increases by a factor of 0.013 as dependent people in the household increases by the household size (Adult Equivalent). The result of this paper is the same with Fekadu and Mequanent, [38], and Girma, [43] research output. This implies as the number of non-productive people in the household the households will be exposed to be food insecure. The non-active labor force will laid the lumber on the active work force.

The household's monthly expenditure found to have a positive relationship with food security level of the household. Household's monthly income is the total monthly income of the household from all sources. The coefficient of this variable is positively significant implying a positive relationship between food security and monthly income. It is significant at 5% which implies the chance of food insecurity decreases by 0.66 with an increase of 1483 Ethiopian birr (Table 11).

Livestock owned had a significant and positive impact on the household food security status of the household. The positive sign of the coefficient indicates that when livestock owned increase by one TLU, the probability of a household to become food secure, *ceteris paribus*, increase by a factor of 0.001. This is because as farmers have a large number of livestock, they become in a better position to be more food secure than farmers who own few. Animals have so many purposes like the source of food and income, non-human labor and transportation. The result is consistent with the research finding of Fekadu and Mequanent, [38]: Bekele et al., 2013.

In addition number of livestock, ox has positive relationship with household food security. The result is fully in conformity with the prior expectation. The result implies the logit increases by a factor 1.282 as the number of ox in the household increases by one unit. Here, like most domestic animals, ox has so many purposes like food, non-human labor and agricultural work. An increase the number of ox will leads to more food secured. The finding is the same with Bekele et al, 2013; Arega, [2] and Idrisa et al, [45]. This result is also consistency with the prior expectation

Distance from market affects food security status negatively and significantly at 1 percent probability level in the study area. The negative relationship may indicate that in the study area, households who are traveling long distance to the market are high food insecure. This result fully agrees with prior expectation. The log-odd ratio implies that the probability of being food secure decrease by approximately 1.385 as households traveled extra one kilometer. The households are both consumer and producer as far as they are going long distance to purchase farm input, consumption goods and sell their farm output this cost farmer to lose more money which leads to being food insecure. The result is consistent with prior expectation and the finding of Fekadu and Mequanent, [38], and Fisher and Lewin, [44].

The non-farm activities showed a positive relationship with food security and are significant at five percent probability level. The odds ratio reveals that for non-farm activity participant households the likelihood of being food secure increased by 1.06. The positive relationship implies that households with access to non-farm activities service have high chance to be food safe than without access ones. This result is fully inconsistency with the prior expectation. This is due to the fact that non-farm activities gives the household an opportunity to be involved in income generating activities so that derived revenue increases financial capacity and purchasing power of the household to escape from risk of food insecurity. Moreover, it helps to supple consumption through generating income when household face with momentary food problem. This result confirms the findings of Mitiku and Legese, 2014: Girma, [43]. Hence, it is expected that the availability of off-farm/non-farm income is positively associated with household food security.

5. Conclusion and Recommendation

5.1. Conclusion

This study tried to assess the food security status of the study area using calorie consumption, to identify the determinants of food security and coping mechanism. The study found that 42 percent were food insecure and 58 percent secure households.

The study used both descriptive and econometrics method of analysis. The descriptive analysis showed that the number of food insecured female household is higher in proportion than male, married food secured household headed greater than married food insecure household headed, majority of the respondents were illiterate, there were more dependent people in food insecure household, food insecure households have low access to land, ox, livestock, improved seed, credit, fertilizer, saving, remittance and non-farm activities.

Food insecure household went the long distance as compared to food secured households. The primary occupation of the household was farming. Most the respondents believed as there is crop failure in the study area. The focal food items that are consumed in the study area were wheat (48.75%), sorghum (15.62%), Teff (11.25%), maize (10.12) and Haricot Bean (8.75%). As the same time the primary sources of food items production (52.67%), free relief food (26.82%), and food for work safety net transfer (5.83%).

The monthly and yearly expenditure of the household were low. Greater part of the household believed as they are food insecure which was different as it has been calculated using caloric approach. In addition, 85 percent of the household didn't cover their consumption through their own production. They can cover only seven months. Free relief food and safety net program played great role to fill good gap in the study area. Since non-farm income of the rural households has significant effect on the food security status of the rural households, farming households should be assisted to diversify their sources of income so that they may be able to meet their minimum food requirement particularly during the off season.

The econometric analysis implied among the variables entered the model aged of household, dependency ratio, average monthly expenditure, distance from input market, non-farm income, household size, farmland size, the number of oxen and livestock ownership were found to be significant in determining household food security. Except for household size, dependency ratio and distance from input market affect the age of household, average monthly expenditure, non-farm income, farmland size, the number of oxen and livestock ownership affect food security positively.

5.2. Recommendation

Based on the finding the followings are the policy proposals.
- Development of irrigation and construction of local dams may boost household's food security.
- Since most of the household head was found to be uneducated, expansion of education for seniors and family will help the household to secure their food demand.
- The econometrics and descriptive statistics revealed that livestock and ox have a positive and significant effect on food security in the study area. Then, the production of the livestock sector should be strengthened through the provision or supply of better veterinary services.
- The people are considering safety net program and food aid as the obligation of the government, and still, it didn't bring a significant change on the people. The government should revise these programs.
- Accesses to modern farm technologies like improved seed, fertilizer and farm credit found at a low level. The provision of these technologies by the government with an educational base for farmers is indispensable for protecting food insecurity.
- During the current time, NGOs were helping the people through water supply and giving animals to minimize the effect of the drought. But also, more is expected from them to provide training and education on resource mobilization and action-oriented program implementation.
- In the rural area, it better to increase employment opportunities and private sectors by the government to minimize the effect of food insecurity plus to create a permanent settlement.
- The loan is given by a business plan which is prepared by agricultural officers that farmers haven't known at all, which is redundantly done. It is better to develop a business plan based on the interest of the borrowers by ACSI.

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