Addis Ababa University

School of Graduate Studies

Master's Thesis

Determinants of Food Insecurity in Rural Households in Tehuludere *Woreda*, South Wello Zone of the Amhara Region

By

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List of abbreviations

CSA	Central Statistical Agency
FAO	Food and Agricultural Organization
FDRE FSS	Federal Democratic republic of Ethiopia Food Security Strategy
HIV/AIDS	Human Immuno Virus/Acquired Immuno Deficiency Syndrome
IFPRI	International Food Policy Research Institute
LR	Likelihood Ratio
MRA	Minimum Recommended Allowance
ORDA	Organization for Rehabilitation and Development in Amhara.
PSNP	Productive Safety Net Program
VIF	Variance Inflation Factor

Abstract

The main objective of the study was to identify some of the factors that influence household food insecurity in Tehuludere Woreda, South Wello Zone. A stratified random sampling method was employed to select the final sampling units. The study period was from November 2005 to November 2006. A household food balance food model was adopted and the recommended daily calorie requirement was used to determine the household food security status. Household food insecurity causation was then examined using logistic regression model.

The descriptive analysis of the study revealed that only 30.8% of the sample households were food secured. The food insecure households (69.2%) felt short of the recommended calorie requirement by 37% while food secure households exceeded the recommended calorie requirement by 44%. Using the forward step wise (likelihood ratio) method, seven out of ten predictor variables were selected as major determinants of household food insecurity. These predictor variables had significant joint and separate influence in explaining the variation in the outcome variable. Model diagnostic tests of the multivariate logistic regression model show the adequacy of the fitted model. The study revealed that non-participation in off-farm activities, having large family size (larger than the sample mean), low annual production or yield (less than the sample mean annual yield), small farm size (smaller than the sample mean farm size), dependency attitude on food aid, poor wealth status (less than the sample mean Tropical Livestock Unit) and insecure land tenure perception as positive and significant factors that contributed to high food insecurity.

Analysis of the marginal effects of significant discrete predictor variables showed that, holding other variables constant, a shift to participation in off-farm activities decreases the probability of household food insecurity by 66%. Holding other variables constant, a shift to smaller family size (smaller than the sample mean family size) decreases the probability of food insecurity by 63%. A shift to high yield (larger than the sample mean) and large farm size (larger than the mean farm land size) decreases the probability of

household food insecurity by 39% and 42%, respectively. Holding other variables constant, a shift from dependency attitude to self-reliance decreases the probability of food insecurity by 25%. A shift to good wealth status (larger than the sample mean TLU) and an improvement in land tenure security decreases the probability of household food insecurity by 38% and 31%, respectively. A simulation study conducted using food insecure households as a reference group indicated that improvement in seven predictor variables have the potential to increase the number of food secured households in Tehuludere Woreda.

The Cronbach's alpha value of 0.628 indicated that the data has a good internal consistency reliability.

CHAPTER ONE: INTRODUCTION

1.1 General

Ethiopia has been facing challenging problems ranging from those induced by environmental crises to those caused by demographic and socio-economic constraints that adversely affect peoples' production system. Ethiopia is among the poorest and most food insecure countries of the world where 44% of its population live below the national poverty line (World Bank, 2005); and 46% of its population get below the minimum levels of dietary energy consumption compared with other sub-Saharan and developing countries (World Bank, 2005). In terms of food security, Ethiopia is one of the seven African countries that constitute half of the food insecure population in sub-Saharan Africa (Sisay, 1995). According to the Food and Agricultural Organization (FAO) report of 1999, average caloric intake in rural areas is 1,680 kilo calories per person per day, which is far below the national medically recommended minimum daily intake of 2,100 kilo calories per person per day. As per the Federal Democratic Republic of Ethiopia Food Security Strategy (FDRE FSS) issued in 1996, the recommended minimum daily intake of 2,100 kilo calorie per person per day is equivalent to 225 kilogram of grain per person per year. In 2005, infant and child mortality rates were 110 and 169 per 1,000, respectively, which is higher than the sub-Saharan Africa and other low-income developing countries; with the lowest life expectancy at birth of 42 years (World Bank, 2005).

Although agriculture is the mainstay of the Ethiopian economy, poverty contributed to its poor performance, which creates supply problems directly and demand problems indirectly by denying the producers' access to sufficient income. In most cases, shortage of food supply is high before harvest. This is because the previous year's stored grain is nearly finished and market prices are high. For several years, the performance of agriculture is poor to the extent that the country could not adequately feed its population from domestic production. This has been manifested in the prevailing food insecurity, both chronic and transitory, which has almost become a structural phenomenon and the way of life for a significant proportion of the population of the country.

1.2. Background of the Study Area

Tehuludere *Woreda* is one of the 17 *Woredas* of the South Wollo Administrative Zone, which is located in Amhara National Regional State of Ethiopia. The *Woredas* of Worebabo in the East, Kutaber in the West, Wuchale in the North and Dessie in the South surrounds it. Its capital town, Haik lies 30 kilometer north of Dessie on the main road to Woldia and 460 and 420 kilometer away from Addis Ababa and Bahir Dar, respectively. The *Woreda* is administratively divided into 16 rural and 4 urban *Kebeles*. According to the 2006 report of the Central Statistical Agency (CSA), the total population of the *Woreda* is estimated about 165,188 of which 84,059 (51%) are female. The population density in the *Woreda* is 303.2 per square kilometer, which made is the third highly dense area among 17 *Woredas* of the South Wollo Zone. According to CSA (2006), the average family size of a household is 5.2, which is almost similar to the national figure. The average land holding size of a household is 0.81 hectare (CSA, 2006).

According to the Tehuludere *Woreda* Agriculture Office, the total area of the *Woreda* is estimated at 48,469 hectares; out of which, 47% is cultivable, 1.5% grazing land, 31.2% bush and forestland, 9.8% used for settlement, 8.3% water body and the remaining 2.2% is of no use. The altitude of the *Woreda* ranges from 1,400 to 2,928 meters above sea level. It has three distinct agro-ecological zones of highland 13%, midland 72% and lowland 15%. The topography of the area is dominated by rugged terrain (48%), about 26.4% mountainous, 13.3% plain and the remaining 12.3% gorge. The major soil types include 15% Red, 40% Brown, 25% Black Vertic, 10% Black Non-Vertic and 10% Gray. The predominant ethnic groups living in the *Woreda* is Amhara, 99%. The rest include 0.35% Tigrie, 0.5% Agew and 0.07% Oromo. The majority of the population, 89%, is Muslims followed by Orthodox Christians, Protestants and Catholics in decreasing order.

Mixed farming is the dominant household activity in the *Woreda* and it is mostly confined to production of a few rain-fed crops such as sorghum, maize, *teff*, wheat, barely, chickpeas and haricot beans. Fishing is also a common household activity. The study area has two rainy seasons: '*belg*" which falls from early March to mid May, and the '*kiremet*' rains, which fall from late June to mid October. '*belg*' crops will be planted in March and harvested in June. On the other hand, the long cycle '*meher*' crops will be planted in July and August. All '*meher*' crops are usually harvested in the period between October and December, with the main cereal harvesting months of November to December. Agricultural productivity, however, is low due to traditional methods of cultivation, erratic rainfall and soil erosion. There is high variability in year-to-year agricultural production. Fragmentation of land holdings is another problem. The perception of farmers in agricultural extension packages and off-farm employment opportunities are very limited. In contrast to other *Woredas*, the road networking in this area is in a better condition. The main road from Addis Ababa to Mekele crosses the area into the north south direction. There is also one all weather road from Haik to Bistima that connects Tehuludere and Werebabo *Woredas.* All the peasant associations are not as such far from these roads. As a result of this, market accessibility in this area is relatively good.

The *Woreda* is believed to be one of the chronically and seasonally food insecure areas of the Amhara Region. It has been repeatedly exposed to recurrent drought and famine and was in fact labeled as the epicenter of the drought in Wollo. The total production is persistently inadequate to cover food requirement of the population. This is mainly due to high population growth, unimpeded environmental degradation, poorly developed infrastructure and the recurrent drought. Due to such reasons, it has long been a food deficit *Woreda* with widespread and deepening seasonal food insecurity situation.

The main reasons for selecting Tehuludere *Woreda* as the area of the study were: (a) rural farmers in this *Woreda* were exposed to a number of natural and man-made disasters. As a result, they have been repeatedly prone to seasonal food insecurity even during the periods of good rain and harvest season; (b) Tehuludere has been labeled as typical food insecure area despite various food and nutrition security interventions made by the government and non-government organizations and (c) The researcher's employer is actively working in integrated rural development projects in the study area and also supported the study in many ways.

1.3. Statement of the Problem

In Ethiopia, food insecurity is predominantly chronic in its nature; with the exception of 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 generally good. Chronically food insecure areas coincide with areas of low and unreliable rainfall, high population density and low resource endowments. Population pressure pushed farming out into marginal lands where it is not suited to the highland farming systems. The impact of recurrent drought has decreased the asset base further these repeatedly drought affected areas of the country, leading to destitution. The problem deepens when resource poor or people with no assets are further affected by extended drought effects. A loss of assets in general makes it very difficult for households to get back to their normal life within a short time unless and otherwise there are appropriate responses.

In Ethiopia, 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. According to various sources, some 42 periods of food shortage including the 1999 and 2000 food shortages have been recorded in Ethiopia (Webb *et al*, 1992), most of which were concentrated along two broad belts, generally described as drought and famine prone areas. One of these is the *mixed farming* production system area of Northern Shewa through Wello into Tigray. Most of the land resources (mainly the soils and vegetation) of this part of the country have been highly degraded because of the interplay between some environmental and human factors such as relief, climate, population pressure and the resultant over-cultivation of the land, deforestation of vegetation and overgrazing. The second belt is the range-based on pastoral economy of low land Ethiopia, ranging from Wello in the north through Hararghe and Bale to Sidamo and Gamo Gofa in the South. Apparently, this belt is generally considered as resource poor with limited or no potential and hence highly vulnerable to drought. The present study area, Tehuludere *Woreda*, is one of the drought prone *Woredas* of South Wello Zone that is located along the escarpments of northeastern highlands, which exhibits the underlying constraints characterizing the area under the first belt. The major food shortage belt in the country is depicted in Annex II of this study.

Per capita growth of production of major food items in the study area have not been sufficient to satisfy the demand of an increasing population. Rate of population growth is increasing due to lack of knowledge on family planning services on the part of the household head, limited or no health related service providers and socio-cultural influence. For example, a household who has larger family size (children) is considered to be rich in the society. Although the seriousness of food shortage varied from year to year, farm households faced seasonal food shortage almost every year. Food insecure and food secure farm households reside as neighbors and could share common climate and weather situation and mainly similar socio-economic, cultural and land topography. Yet, one faces seasonal food crisis and become dependent on food aid, while the other remains food secure, requiring no food aid. Recent literature discovered that even in years of adequate rainfall and good harvest, the households in the study area remain in need of food assistance. This clearly reflects the deeply entrenched poverty and transitory situation of the area irrespective of adequate rainfall. Although drought plays a paramount role in triggering food crisis the difference in consumption status of farm households between good year and bad year is not so significant to claim that drought is central cause of famine or transitory food insecurity. This implies the existence of structural, socio-economic, cultural, demographic and other factors underlying the poverty and seasonal food insecurity problem in the study area. Accordingly, the central research question of this study is what factorial differences make one household food secure and the other seasonally food insecure.

1.4. Objectives of the Study

The general objective of this study is to identify the most important factors influencing food insecurity in rural households of Tehuludere *Woreda*, South Wollo Zone.

The specific objectives of the study are:

i. to examine the effects of some variables that may influence food insecurity of rural households and identify the most important determinants;
ii. to describe the relationship between food insecurity and its determinants; and
iii. to analyze the impact of major determinants on the probability of household food security.

1.5 Limitations of the Study

The study focused on identifying some of the factors that were expected to influence household food insecurity in rural parts of the Tehuludere Woreda. Due to lack of database, the study could not incorporate some of the most important influencing factors such as climate and weather (rainfall, temperature); topography; natural disasters and ecological conditions. The study did not make a comparative analysis of food insecurity problem between urban and rural *Kebeles*. The study was concerned about transitory food insecurity faced by farm household for any magnitude ranging from mild to severe and hence did not deal with causes of chronic food insecurity. In determining the available calorie by the household head, the study used cereal products only and it did not include other products (oil seeds, vegetables, fruits, etc) which might be consumed by the household in the year under study. This means the aggregate production (yield) consists of cereal output of the household only. In addition, of the different nutrients derived from the consumption of cereal foods, only calories were considered.

Dichotomizing the outcome variable for the sake of comparing the available calorie amount and the national recommended 2,100 kilocalorie per day per person could lead to a loss of information. For example a household head who have 2,099 kilo calorie per day person and another household who have 800 kilo calorie per person could be categorized as food insecure while their level of insecurity is different. Because of lack of secondary information, it was not possible to get conversion factors to change each member of the household head (infants, male, female and age differences) into the corresponding adult equivalent. In determining the number of predictor variables, this study considered a rule of thumb of having a minimum of 10 observations for each predictor variable. The univariate approach ignored the possibility that a collection of variables, each of which is weakly associated with the outcome variable, could become an important predictor of outcome when taken together.

CHAPTER TWO: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Overview of Studies on Food Security

2.1.1 Conceptual Framework and Definitional Considerations of Food Security

The term food security originated in international development literature in the 1960s and 1970s. At that time the conventional wisdom was that food insecurity was conceived primarily as a supply issue at an aggregate level because of the significant shortfalls in food supply and high food prices in the world market in the early 1970s. However, despite the favorable supply conditions and low food prices after mid 1970s, the incidence of food insecurity remained high in many developing countries (Sijm, 1997). This anomaly of widespread food insecurity amid a world of surpluses stimulated the analysis of the nature and causes of food insecurity.

In the early 1980s, however, a paradigm shift occurred in the field of food security following Sen's (1981) claims that food insecurity is more of a demand concern, affecting the poor access to food, than a supply concern, affecting availability of food at the national level. Since then, accepted wisdom has defined food insecurity as being primarily a problem of access to food. At the same time, the unit of analysis shifted from the global and national level to the household and individual level. Overtime a large number of different definitions have been proposed. A report by Maxwell and Frankenberger's (1992) lists 194 different studies on the concepts and definition of food security and 172 studies on indicators. There are approximately 200 definitions and 450 indicators of food security (Hoddinott, 1999)

Several studies have explored the similarities among definitions of food security to identify its fundamental components. According to the World Bank report, the conventional food security is defined as *"access by all people at all times to enough food for an active and healthy life"* (World Bank, 1986). This indicates that the cause of food insecurity could be other factors such as a loss of endowments, unemployment, a fall in wages or unfavorable shift in the terms of trade of food in exchange for assets. This consideration enabled to move a step forward in entailing not only *food availability* (adequate supply of food) but also *food access* through home production, purchase in the market or food transfer.

In 1996, the World Food Summit held in Rome declared and broadly set the definition of food security as "*all people at all times have physical and economic access to sufficient, safe and nutritious foods to meet their dietary needs and food preferences for an active and health life*". Although there were agreements on some aspects of food security, controversies also existed. These include: relative importance of supply (food availability) versus demand (food access) variables in causing and solving food insecurity, the right indicators to measure food security, the impact of policy interventions on food security in the recent past, and the lessons or policy implications for the near future to reduce the extent of food insecurity.

At present, a combination of these definitions with focus on three components of food security: *availability, access and utilization* are serving as a working definition. In the context of subsistence farm households, food security refers to the ability to establish access to productive resources such as land, livestock, agricultural inputs and family labor combined to produce food or cash (Tolosa, 1995). Consistent with this, Bonnard (1999) argued that with respect to the three components of food security, agriculture constitutes the most important factor in availability, a primary factor in access where livelihoods are agriculture-based and a complementary factor regarding food quality and processing for utilization.

Based on temporal dimension, two types of household food insecurity can be distinguished as *chronic and transitory*. *Chronic (permanent) food insecurity* is a continuously inadequate diet resulting from lack of resources to produce or acquire food, while *transitory food insecurity* is a temporary decline in the household to access enough food (World Bank, 1986; Reutlinger, 1987). A household is said to be food insecure when its consumption (available food) falls below the daily standard Minimum

Recommended Allowance (MRA) of caloric intake for an individual to be active and healthy. The worst form of transitory food insecurity is famine. Hence, this study is concerned with a transitory food insecurity faced by farm households of any magnitude ranging from mild to severe. In this study, the concepts of transitory food insecurity and seasonal food shortage are synonymous and will be used interchangeably.

2.1.2 Causes of Seasonal Household Food Insecurity

The literature review on determinants of household food security for this study is structured under three sections. The first section presented some of the cases of seasonal food insecurity documented in some other countries. The second part summarized some of the previous studies conducted concerning seasonal food shortages and famines experienced in Ethiopia over the recent past decades. The last section deals with the empirical findings about determinants of household food security.

2.1.2.1. Causes of Seasonal Food Shortage in Other Countries

The major challenge to food security in Africa is the underdeveloped and underperforming agricultural sector that is characterized by over-reliance on primary agriculture, low fertility soils, ecological degradation, significant food crop loss both pre- and post-harvest, low levels of education, social and gender inequality, poor health status, cultural insensitivity, natural disasters, minimal value addition and product differentiation and inadequate food shortage of preservation that result in significant commodity price fluctuation (Mwaniki, 2005). All factors, however, can be related in some fashion to two basic causes: insufficient national food availability and access to food by households and individuals.

The evolution of the problem varied in different parts of sub-Saharan Africa. In seven sub-Saharan African countries (Angola, Chad, Chad, Ghana, Malawi, Mozambique and Namibia) the proportion of the undernourished substantially decreased, while others have gone through a deterioration process (Kidane *et al* 2006). About 80% of the increase in the proportion of the undernourished is observed in conflict countries, where famine has been widespread. The type of food insecurity observed in sub-Saharan Africa is a combination of widespread chronic food insecurity, resulting from continuing or structural poverty, transitory emergency-related food insecurity, which occurs in periods of intensified pressure caused by natural disasters, economic collapse, or conflict (FAO, 2004).

Many factors have also contributed to this tendency including the high prevalence of HIV/AIDS; an overall decline in farm input investment including fertilizers, seeds, and technology adoption. Access to fertilizer use is constrained by market liberalization and trade policies that increase fertilizer prices relative to commodity prices, limited access to markets and infrastructure, limited development of output, input and credit markets, poverty and cash constraints that limit farmer's ability to purchase fertilizer and other inputs (Kherallah *et al*, 2002). Other causes include: limited access to agriculture-related technical assistance, and lack of knowledge about profitable soil fertility management practices leading to expansion into less-favourable lands. A significant amount of the food is lost through pre- and post-harvest losses. The tropical climate makes foods produced in these regions prone to pests and diseases.

While food availability is still a problem for some countries, the root cause of food insecurity in developing countries today is believed to be the inability of people to gain access to food due to poverty (Von Braun *et al,* 1994). The study by Mwaniki (2005) supported this view and reported that the root cause of food insecurity in developing countries is the inability of people to gain access to food due to poverty. According to Bonnard (1999), much of the sub-Saharan African population, particularly in rural areas, experiences some degree of hunger over the rain or "hungry" season, when food stocks dwindle and roads become muddy and impossible. Grain was short during the planting season and the problem was largely attributed to poor allocation of resources and poor rationing (Bonnard, 1999). Migration of male labour was also recognized as a cause of seasonal hunger.

A study conducted in a Lesotho village found that women and children suffered from lack of food and poor hygiene because women were too exhausted to cook and clean at times of peak agricultural work (Driba, 1996). Haswell (1953) observed that growing cash crops at the expense of subsistence crops has largely contributed to seasonal food deficit among the Gernier in Gambia. Illness of adults at critical times in the production process adversely affected labour efficiency and productivity, which in turn contributed to seasonal food shortage (Haswell, 1953). A study conducted by Obamiro *et al* (2003) in South-western Nigeria showed that illness will decrease productivity; therefore increases in day's loss to illness will decrease food availability and accessibility. As a result illness will likely shift family members from the food secure to the food insecure status.

In several African countries, deterioration in the ecological conditions of production has also been seen as a cause of seasonal hunger. Ogbu (1973) noted insufficient farmland, low yields on farms and high storage losses of staples were the principal causes of seasonal food shortage in Nigeria. A study conducted in Mali by Toulmin (1986) reported that seasonal food shortages that are mainly induced by two principal factors: (i) low and highly variable rainfall making the people very vulnerable to crop failure, and (ii) high levels of mortality, varying levels of fertility and vulnerability of all producers to sickness and disability.

2.1.2.2. The Ethiopian Case

The food security situation in Ethiopia has been extremely unstable due to the combination of environmental, socio-political and developmental instabilities. Lack of food in the household imposes inordinate strains on the daily burdens of its members. Coping mechanisms have been eroded in many households due to significant depletion of assets and displacement. Current conventional wisdom on food insecurity in Ethiopia asserts that the problem can be conceptualized as follows: (i) landholdings are too small to allow most farming households to achieve food production self-sufficiency; (ii) population increase reduces landholdings further and places intolerable and limited application of yield-enhancing inputs; (iii) recurrent drought and food production shocks to abnormally low yields; (iv) limited-off farm income employment opportunities restrict diversification and irrigation options, leaving people trapped in increasingly unviable agriculture; (iv) redistribution of land by the state has achieved socially equitable outcomes, but at the cost of household food security. Fears of further redistribution generated tenure insecurity which resulted in some cases unwillingness to invest effort in measures to improve soil conservation and enhance fertility.

Although food insecurity as problem at national level was first felt in Ethiopia in 1960s, it only started “influencing” policy in the 1980s when food self-sufficiency became one of the objectives of the Ten-Year Perspective Plan that took place after the 1983/84 drought and famine, which claimed millions of lives (Haile *et al,* 2005). Since then proper “transitory food insecurity” has received little considerations despite its prevalence even in “normal years” as well as in “high potential” and “surplus areas”. The National Policy on Disaster Prevention and Management of 1992/93 emphasized the need to give priority to disaster prevention programs in all development endeavors. The Federal Food Security Strategy (FDRE FSS, 1996 updated in 2002) rested on three pillars: increasing supply and availability of food, improving access and entitlement to food and strengthening emergency response capabilities. The New Coalition for Food and Livelihood Security in Ethiopia adopted in 2004 aimed at improving access to long-term food and livelihood security for chronically and seasonally food insecure citizens through its various food security programs. In 2005, the Ethiopian Government launched the Productive Safety Net Programme (PSNP) with the objective of facilitating transfers of food or cash to chronically food insecure *Woredas* without depleting assets at household level and creating assets at community level.

Woldemariam's (1991) investigation in Northcentral Ethiopia indicates that most farmers could not produce enough to meet the annual requirements from the farmers' annual requirement perceptions. Tolosa (1996) in his study conducted in Arssi, a zone considered to be a surplus grain producer at an aggregate level, examined the seasonal food shortage among farm households and variations between households practising double cropping (during *meher* and *belg* seasons) and those relying on a single harvest (*meher*). The proportion of farmers practicing double cropping and single harvester who reported to have faced seasonal food deficit was 29% and 52%, respectively. An assessment of the causes of transitory food insecurity identified various physical and socio-economic constraints to subsistence production. These were insufficient farmlands for 99% of the households, lack of cash income to purchase farm inputs for 79% of the households, poor quality of their farmland for 67% of the households, reliance on single harvest for 55% of the households, and shortage of pulling power for 33.7% of the households. The study pointed out that 69.7% of the households encountered food deficit before *meher* harvest and about 23.6% of the households before *belg* harvest (Tolosa 1996).

Another research finding by Ezra (1997) showed that "household's average cereal production during normal harvest years is persistently lower than annual food requirements and hence many households feed themselves from their farm outputs only for less than three-fourth of the year. According to Negash (2000) study in Meket, Habru and Gubalafto *Woredas* of North Wello Zone, 30%, 21% and 40% of the sample households, respectively, were unable to satisfy the food demand of their family for more than five months in a year. Based on an empirical study in Northern Shewa, Amare (1999) argued that the seasonality of agriculture introduced fluctuations in the income, expenditure, and nutritional patterns of peasant households. He further stated, "the coincidence of diminishing grain supplies and increasing grain prices was a liability for the economic status and food security of households" (Amare, 1999).

Woldemariam (1984) came out with model that demonstrated the major factors for farm households' vulnerability to famine. He stated that vulnerability to famine is a product of a system, that is, a subsistence production system, which consists of three components: the peasant world, the natural forces (physical environment) and the socio-economic forces. Regarding the relationship between these factors, Woldemariam (1984) argued that an agricultural population must first be made vulnerable to famine by socio-economic and political forces before any adverse natural factor initiates the process of food shortage that leads to famine.

Webb *et al* (1992), in their study on Ethiopian famine, found strong positive correlation between famine and poverty. Accordingly, a number of interrelated factors that contribute to famine are: proneness to climatic-driven production fluctuations, lack of employment opportunities, limited asset bases, isolation from major market, low level of technology, constraints to improvements in human capital and poor health and sanitation environments. The other quite remarkable observation made by the study is that famine does not happen suddenly - famine builds on high levels of food insecurity that the present households cannot withstand and that the government is not prepared for (Webb *et al,* 1992).

Similarly, Tolosa (1995) concluded that households' risk of food insecurity and famines were greatly increased by long-term secular decline in resource endowment, combined with unfavourable food policy intervention. Emphasizing on subsistence farmers' food insecurity situation, he underlined that the prevailing inability of Ethiopia's small-scale agriculture to feed its population is mainly generated by the neglect of the policy and the decline in access to productive resources upon which most of the livelihoods are built. A community assessment study on 21 *Kebeles* of South Wello and Oromiya Zones of Amhara Region, which was conducted by Amare *et al* (1999) reported factors such as drought, crop pests, frost, rust, hailstorms, untimely or excessive rainfall, land shortages and degradation, lack of oxen, population growth and diseases resulted in severe food shortages and household food insecurity.

2.1.2.3. Determinants of Household Food Security Status

Much of the literature on seasonal food insecurity analyzed factors that influence seasonal food insecurity of rural farm households using appropriate regression models. Wilma *et al* (2003) used a logistic regression model to predict seasonal household food insecurity. According to their findings, the probability of a household being seasonally food insecure decreased, when the household has a vehicle, has many types of appliances, their toilet facility is water-sealed, has more bed rooms, the mother is employed and the educational attainment of the mother is high.

Ramakrishna *et al* (2002) made an assessment on food insecurity situation in North Wello Zone of Ethiopia. A food balance sheet was constructed and food security causation was examined using a binary logistic regression model. Accordingly, cereal production, educational status of the household head, fertilizer consumption, household size, land size, and livestock were found to be the most determining factors of household food security. Along with food availability and entitlement factors, the study suggested that attitudinal variables also influence food insecurity Ramakrishna *et al* (2002).

A study by Kidane *et al* (2005) reported the causes of household food insecurity in Koredegaga peasant association, Oromia Zone. The study showed the determinants of households' food insecurity using a logistic regression procedure. As a result, farm land size, ox ownership, fertilizer application, education level of household heads, household size, and per capita production were found to be significant predictors. The analysis of partial effects revealed that an introduction to fertilizer use and an improvement in the educational level of household head resulted in higher changes in the probably of food security. Simulations conducted on the basis of the reference category of farmers, representing food secure households, revealed that both educational levels of household heads and fertilizer applications by farmers have relatively high potential to more than double the number of food secure households (Kidane *et al,* 2005).

In view of the reviewed literature, this study examined the most important factors that influence food security status of rural households in Tehuludere *Woreda* of the South Wollo Zone.

2.2 Comments on Studies on Food Security

Over the recent past, the perception on food security has changed significantly. Food insecurity was conceived primarily as a supply issue at an aggregate level because of the significant shortfalls in food supply and high food prices in the world market in the early 1970s. However, despite the favorable supply conditions and low food prices after the mid-1970s, the incidence of food insecurity remained high in many developing countries (Sijm, 1997). This anomaly of widespread food insecurity amid a world of food surpluses stimulated the analysis of the nature and causes of food insecurity. Following Sen's (1981), a paradigm shift occurred in the field of food insecurity as being primarily a problem of access to food and the unit of analysis focused at household and individual level.

In Ethiopia, despite planned and unplanned interventions, food insecurity remained a deep-rooted problem and is on top of the country's development agenda. Although the food insecurity problem has been chronic for many years, interventions have been geared towards short-term solutions without substantial results. The fundamental causes of seasonal food insecurity have not been properly targeted or addressed. Although the National Policy of Disaster Prevention adopted in 1992 was designed to link relief efforts with development, by changing the mode of interventions and utilization of food aid resources, it has not been adequately practiced. In many seasonally food insecure areas of the country where food aid programmes have been implemented for a long time, food aid has not been integrated with other essential polices and measures, such as reducing population growth rates to reduce pressure on agricultural resources. The recently adopted New Coalition for Food Security and Safety Net Programmes may somehow address the food insecurity problem if properly implemented through plans that integrate the development of currently food insecure *Woredas* and relatively productive *Woredas*.

Much of the reviewed literature on household food security concentrated on describing qualitatively and quantitatively, the extent of household food insecurity; identifying the factors and examining their implications. In almost all studies reviewed, there were no statistical explanations on determining sample size. Besides, the central tasks of regression analysis: the parameter estimation techniques and variable selection methods were not addressed. Most of the reviewed model based studies on household food security did not check model adequacy: detection and treatment of outliers, influence diagnostics and multicollinearity that deserve attention while modeling relationships between variables. All of the revised studies did not report the about the analysis of the effects of interaction terms. In this study, a model that could explain factors that influence the probability of household food insecurity was fitted taking into account the limitations described in the reviewed literature.

CHAPTER THREE: METHODOLOGY

3.1 Data Source and Sampling Technique

The research instruments that were employed under this study were primary and secondary data. Primary data were collected through administering a structured questionnaire to rural households in Tehuludere *Woreda*. The questionnaire was designed to gather qualitative and quantitative data pertaining to demographic, resource endowments, farm technology use, attitudinal and other aspects of households including food and non-food consumption and expenditures for the period covering November 2005 to November 2006. The questionnaire is found in Annex I of this study.

Prior to the actual data collection, emphasis was made on 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 in terms of variance. When the variance is unknown, Cochran (1977) listed four ways of estimating population variances for sample size determination: (i) take the sample in two steps, and use the results of the first step to determine how many additional responses are needed to attain an appropriate sample size based on the variance observed in the first step data; (ii) use pilot study results; (iii) use data from previous studies of the same or similar population; (iv) estimate or guess the structure of the population assisted by some logical mathematical results. Observations from literature review indicated that there were some empirical studies of similar character reported in 2003 by the Tehuludere Nutrition Survey Report and commissioned by Organization for Rehabilitation and Development in Amhara (ORDA) and Tehuludere Agriculture Office. According to these reports, the average proportion of food insecure households in the *Woreda* during the past five years was 0.587. Using the estimated average proportion of food insecure households, the required sample size for the study, with level of significance $\alpha = 0.10$ was determined as 182. Since this sample size did not exceed 5% of the population, which is 20,495 rural household heads, Cochran's (1977) finite correction formula was not applied to calculate the final sample size.

The final sampling units were selected by using stratified random sampling technique as described below. The *Woreda* has 16 rural *Kebeles*, which were considered to be strata for this study. The size of the sample in each stratum was determined in proportion to the size of the stratum, termed proportional allocation (Bededo 12; Korke 9; Woldelulu 10; Kete 13; Hitecha 8; Amemo 8; Gobeya 11; Jare 15; Tibisa 15; Kosoro 14; Hardibo 9; Hara 11; Godguadit 15; Mutibelg 10; Gedera 13; Nibokotu 9). Finally, using the data base of households from each *Kebele* Office, a simple random sample of rural household head was taken from within each stratum. Stratification was employed due to administrative convenience and a gain in precision in the estimates of the characteristics of the whole population over the simple random sampling technique.

3.2 Measurement of Variables

The variables that were supposed to influence household's food security status were selected based on experiences from the available studies, the available primary as well as secondary data on the subject. Categorization of the values of some of the predictor variable was made based on their means or quartiles.

3.2.1 Response Variable

To determine the response variable, household food security status (HFS), a Household Food Balance Model (HFBM), which was used by Haile *et al* (2005), Shiferaw *et al* (2004), Ramakrishna and Assefa (2002), Nyariki *et al* (2001), Tolosa (1996) was adapted accordingly. The HFBM was used to quantify the net available grain food by each of the 182 sampled rural households in Tehuludere *Woreda* in the period covering November 2005 to November 2006. All variables required for the HFBM model were then converted from the local grain measurement units into the corresponding kilogram grain equivalent.

The HFBM model was expressed as follows:

$$q_i = [p_i + b_i + f_i + r_i] - [l_i + s_i + m_i + e_i + g_i + d_i]$$

In this model, the index i runs from 1, 2,…, 182 and q_i represents net grain food available for household i; p_i total grain produced by household i; b_i is total grain purchased by household i; f_i is total grain obtained through food-for-work by household i ; r_i is total relief grain food received by household i; l_i is post-harvest crop losses to household i; s_i total crop utilized for seed by household i; m_i is total marketed output by household i; e_i grain used for social events by household i; g_i grains given out to relatives by household i; and d_i repayment of grain borrowed by household i.

With the exception of post-harvest losses, all the data needed for HFBM model were obtained from the primary data gathered for the period November 2005 to November 2006. According to the report of Tehuludere *Woreda* Agriculture Office, post-harvest crop loss during the year under investigation, was estimated at an average value of 15% of the total harvest for each crop.

Finally, following Haile *et al* (2005) and others, the response variable was determined in four steps. First, net grain available for each household in kilogram (q_i) was converted into equivalent total kilo calories using conversion factors used for Ethiopia (Agren *et al*, 1968). Second, the food supply at the household level calculated in step (i) was used to calculate calories available per person per day for each household. Third, following FDRE FSS (1996), 2,100 kilo calories per person per day was used as a measure of calories required (i.e., demand) to enable an adult to live a healthy and moderately active life. Then a comparison between the available (supply) and required (i.e., demand) grain food was made. At last, comparison between calories available and calories demanded by a household was used to determine the food security status of a household. A household whose daily per capita caloric available (supply) is less than his/her demand was regarded as food insecure, and coded as 1, while a household who did not experience a calorie deficit during the year under study was regarded as food secure and was assigned a code of 0. In view of this, the response variable, food security status of the i[th] household, HFS_i was measured as a dichotomous variable:

$$HFS_i = \begin{cases} 1, & Y_i < R \ (food \ insecure) \\ 0, & Y_i \geq R \ (food \ secure) \end{cases}$$

where Y_i daily per capita calorie available (supply); R is the minimum recommended national standard rate of calories per person per day, which is 2,100 kilo calorie (i.e., demand) and HFS_i food security status of the i^{th} household, i =1, 2, 3… 182.

Head count ratio expressed as $H = m/n$, where m = number of food insecure households and n=number of households in the sample was calculated to measure the extent of undernourishment. Besides, a shortfall/surplus index (P) defined as $P = \sum_{i=1}^{m} \frac{(Y_i - R)}{mR}$ was calculated, where Y_i daily per capita calorie intake of ith household and R is the recommended per capita daily calorie intake, which is 2,100 kilo calorie. The index P measures the proportion of shortfall/surplus of the average daily dietary energy intake of the undernourished from the average national nutritional requirements, expressing the depth of undernourishment.

3.2.2 Predictor Variables

The list of predictor variables which were expected to influence household food insecurity were all categorical and grouped under four major classes: socio-demographic characteristics, economic resources and agricultural technology use, attitudinal and other variables. An important modeling consideration for continuous covariates is their scale in the logit. When a logistic regression model contains a continuous independent variable, interpretation of the estimated coefficient will depend on how it is entered into the model and the particular units of the variable. If the assumption that the logit is linear in the covariate is not met, then grouping and use of dummy variables could be considered. In this study, dichotomizing some of the continuous variables was made to have a sound interpretation of predictor variables. In addition when explanatory variables are continuous, it is difficult to analyze lack of fit without some type of grouping. As the number of explanatory variables increase, however, simultaneous grouping of values for each variable can produce a contingency table with a large number of cells, many of which have small counts. In such cases, an alternative way of grouping or categorization forms observed and fitted values based on a partitioning of predicted probabilities. Nevertheless categorizing the continuous covariates for the above mentioned reasons is viable against the loss of vital information.

(i). Socio-Demographic Variables

- AGE = Age of household head (in years).

AGE was used as a proxy for experience of household head since he/she started farming. Younger household heads were expected to have relatively poorer experiences of the socio-physical environments and farming than older household heads. Categorization of AGE was made on the basis of the quartiles of the sampled households.

$$AGE = \begin{cases} 1, & \leq 29 \\ 2, & 30-36 \\ 3, & 37-47 \\ 4, & \geq 48 \end{cases}$$

Apriori expectation of AGE with HFS was positive.

- SEX = Sex of the household head

In this study, female-headed households were expected to be more food insecure than male-headed households. A dummy variable was used to denote this variable with

$$SEX = \begin{cases} 1, & female \\ 0, & male \end{cases}$$

SEX was expected to correlate with HFS positively.

- EDUC = Literacy status of household head.

The impact of education on household food production might be through promoting awareness on the possible advantages of modernizing agriculture through technological inputs and by diversifying household incomes, which in turn enhance household's supply. Households led by non-literate heads are less likely to understand modern farming technologies provided to them through any media (extension workers, radio, etc) than literate household heads. The covariate EDUC assumed binary values and was expected to have a positive influence on HFS.

1, cannot read and/or write

0, can read and write

- FSIZE = Family size of the household head (in number)

The larger the household size (economically inactive) the more implication on food consumption than on labor supply to boost production. In this study, it was expected that the larger the household size, the more likely to have impact on food consumption. The average household size of 5.19 was obtained from the sampled households and used to classify the variable.

$$FSIZE = \begin{cases} 1, & \geq 6 \ \ members \\ 0, & \leq 5 \ \ members \end{cases}$$

The expected effect of FSIZE on HFS was positive.

(ii). Economic Resources and Agricultural Technology Use

- YIELD = Total annual cereal yield (in kilogram) produced by the household head from November 2005 to November 2006.

The lower the amount of grain food obtained from own production, the more likely the household to be food insecure. The mean value of YIELD of the sampled households was 712.59 kilogram and used for categorization.

$$YIELD = \begin{cases} 1, & < 712.59 \ kg \\ 0, & \geq 712.59 \ kg \end{cases}$$

YIELD was expected to correlate with HFS positively.

- TEC = Technology adoption

Technology adoption refers to the use of farm inputs like chemical fertilizer, pesticides, improved seeds, farm credit and access to irrigation water with improved agronomic practices. Households who reported as non-users of all or at least any one of this package of technology were considered as non-adopters. Non-adoption was expected to increase the likelihood of being food insecure through its effect on decreasing farming systems and eventually decreasing food availability and income. Therefore, the expected effect on HFS was positive.

$$TEC = \begin{cases} 1, & non-adopter \\ 0, & adopter \end{cases}$$

- OFFARM=Participation in off-farm income generating activities

Participation in off-farm activities was measured by whether or not a household head involved in diversified income sources such as selling firewood, working on farms as daily laborers and running petty or small trade. Households who did not engage in off-farm activities are more likely to face food deficit if farm income is not enough. A dummy variable was used to denote this variable.

$$OFFARM = \begin{cases} 1, & didn't \ \ participate \\ 0, & participated \end{cases}$$

The expected impact of OFFARM on HFS was positive.

- LSIZE = Farm land size of household head measured in hectares

Farm land size refers to the total farmland owned by the household and measured in hectares. The smaller the farmland owned by the household, the smaller the level of production and the more likely to be food insecure. The mean farm land size of the sampled households was 0.38 hectares and used for categorizing this variable.

$$LSIZE = \begin{cases} 1, & < 0.38 \ \ hectare \\ 0, & \geq 0.38 \ \ hectare \end{cases}$$

The expected effect of LSIZE on HFS was positive.

- TLU= Tropical Livestock Unit

A TLU is equivalent to 250 kilogram of live weight and refers to total livestock ownership of household head. An inventory of livestock for the sample households was taken and each livestock of a household was changed to its equivalent TLU using conversion factors suggested by Agren *et al* (1968) (1 cattle=1TLU; 1 goat=0.15 TLU; 1 horse=1 TLU; 1 mule=1.15 TLU; 1 donkey=0.65 TLU; 1 camel =1.45 TLU and 1 poultry=0.005 TLU). The wealth status of the household head was measured by the number of livestock owned, since livestock is the most important indicator of wealth in rural Ethiopia. A household's level of farm resources (e.g., livestock) can be expected to affect its ability to withstand abrupt changes in production, prices, income or unforeseen events that create the need for additional expenditures. The smaller the wealth status of the household head or TLU that a household head has, the higher the food insecurity. The mean TLU of the sampled households was 2.68 TLU and used for dichotomization.

$$TLU = \begin{cases} 1, & < 2.68 \\ 0, & \geq 2.68 \end{cases}$$

The expected effect of TLU on HFS was positive.

(iii). Attitudinal Variables

- AID = Household's attitude of dependency on food aid

Food aid literature suggests that food aid is a short-term solution to food insecurity and does not contribute to asset creation or rehabilitation of beneficiary communities. In most cases, food aid had a negative effect on the attitudes of farmers towards work and their own agricultural activities. Oxfam GB (2004) reported that some households in Tigray and Amhara regions of Ethiopia even depleted their livestock resources in order to become poor and qualify for food aid. Households feel that they will be disqualified if they produce food grains or their own livestock (Oxfam GB, 2004). In this study, households with dependency attitude on food aid were expected to be more food insecure than others. A dummy variable was used to denote the variable and the expected impact on HFS was positive.

$$AID = \begin{cases} 1, & good \\ 0, & not\ \ good \end{cases}$$

- TENURE = Perceived land tenure security

Ensuring land tenure security enhances farmers' confidence and incentives to invest in land improving technologies and farm management systems. The Ethiopian government tried to address the problems of tenure insecurity through issuing certificates of land use rights to peasants. The predictor variable TENURE measures whether or not the land use certificates issued to farmers contribute to enhance farmers' confidence on land investment. In this regard, a household head was asked whether or not the land use certificate that he/she got enabled him/her feel confident or not. A dummy variable was used to measure TENURE as:

1, not confident

0, confident

The expected effect of TENURE on HFS was positive.

(iv). Other Variables

- YIELD X TLU –interaction between YIELD and TLU. Households with small number of cattle are less likely to resist any risks and hence are more likely to be food insecure.

- YIELD X FSIZE –interaction between YIELD and FSIZE. Households who have larger family size or dependents are expected to be less likely to feed their families sufficiently.
- AID X YIELD – interaction between household's attitude of dependency on food aid and total quantities of own grain food produced. Households who have dependency feeling on food aid are more likely to suspend productive work on their farm plots and spend less time supplying labor to agricultural and non-agricultural activities in preference to aid. Households who have dependency attitude on food aid were expected to be food insecure.
- TENURE X TEC – interaction between perceived land tenure security and technology adoption. Households who felt unsure about their farm land were expected to suspend investment of farming technologies on their land. This will in turn increase their likelihood of being food insecure.

3.3. Comparative Review of Some Qualitative Response Models

The response variable in a regression problem can assume only binary values: either zero or one. Fitting the standard multiple linear regression model of a binary response variable on a set of continuous and/or dichotomous regression encounters violations of some of the fundamental least squares assumptions: homscedasticity, normality of errors, and the predicted values that the regression analysis yield could fall outside the range 0 to 1(Montgomery & Peck, 1992). Some of the statistical methods which were developed to analyze qualitative response regression models where the dependent variable is a 0 or 1 are: Logistic Regression (Collett, 1991; Montgomery & Peck, 1992; Greene, 1993; Agresti, 1992; Haile *et al*, 2005; Getachew, 2000 and others), Disciriminant Function (Hosemer & Lemeshow, 1989; Maddala, 1997), and Probit models (Greene, 1993).

Discriminant analysis is useful to find an equation that brings the optimal mixture of independent variables to predict the appropriate classification of an individual, in terms of its nominal or ordinal scale categories. However, it can only be used with continuous independent variables. Discriminant function analysis makes computations of the estimator easier. However, it is not preferred for fitting a qualitative response variable due to sensitivity of the discriminant function estimator to the association between the outcome variable and the regressor under question that follows, especially when the variable is dichotomous. Moreover, in discriminant function analysis more parameters need to be estimated than in logistic regression model. Press and Wilson (1978) reported that logit is superior to discriminant analysis for classification, primarily because the assumption of multivariate normally distributed characteristics is not reasonable, especially when some characteristics are qualitative in nature.

Linear Probability Model (Linear Regression), with proportion of success as the outcome variable, could be used to fit qualitative response regression model. But, the limitation of this model is that the predicted probability values can lie outside the admissible range 0 to 1 and prediction errors can be very large. Besides, although the linear probability model is often used because of its computational ease, outcomes are sometimes predicted with certainty when it is quite possible that they may not occur. The upper limit difficulty of linear probability model can be addressed by replacing odds ratio in place of proportions. But this too has its own shortcoming in that we cannot logically state the effect of regressor on the odds is linear, as factors that affect the odds are multiplicative (Getachew, 2000). Logit (logarithm of odds) will not only solve the floor constraint of linear probability model but also enables to state the effect of each predictor variable on the logit of the odds (Getachew, 2000).

Probit Model, which is the inverse of the Gaussian distribution, has similar type of limitations and advantages with logistic regression (Collect, 1991). The logistic and probit transformations are quite similar to each other, but from the computational viewpoint, the logistic transformation is more convenient. The logistic transformation is preferred to other transformations due to its direct interpretation in terms of the logarithm of the odds in favor of a success. Besides, models that are based on the logistic transformation are particularly appropriate for the analysis of data that have been collected retrospectively (Collet, 1991).

In some cases, logistic regression is preferred to the probit due to its link to other models, such as log-linear models; its simpler interpretability of the logarithm of the odds ratio; and its importance for retrospectively collected data analysis (McCullar & Nelder, 1989). The logistic model (and hence the logit) is a remarkably flexible model and it is unlikely that any alternative model provided a better fit for binary response variables if the data is free from outliers and other inconveniences (Hosmer-Lermeshow, 1989). The interpretability of the differences of the logit scale whether the data are sampled prospectively or retrospectively makes the model distinguishable from other qualitative response models McCullagh and Nelder (1983).

3.4 The Model

3.4.1 Logistic Regression

Logistic regression can be used to predict a response variable on the basis of continuous, discrete, dichotomous, or a mix of any of these predictor variables; to determine the percent of 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. Logistic model has powerful predictive power. Its close relationship to log-linear analysis of contingency table and linear discriminant function analysis made the logistic model more popular 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 (Copas, 1988). 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. 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 logistic regression model. These include: meaningful coding, inclusion of all relevant and exclusion of all irrelevant variables in the regression model, low error in the explanatory variables, linearity in logits, independent sampling, no outliers, no multicollinearity and sampling adequacy.

Logistic regression has a peculiar property of easiness to estimate logit differences for data collected both retrospectively and prospectively (McCullagh and Nelder, 1983), have contributed a lot to its importance in application areas. Because of the reasons discussed above, the logistic (logit) regression model was used in order to address the issues under objectives (i), (ii) and (iii) of this study. The logit model is defined as follows.

Let $\mathbf{Y}_{n\times 1}$ be a dichotomous outcome random variable with categories 1 (food insecure) and 0 (food secure). Let $\mathbf{X}_{\mathbf{n\times(p+1)}}$ denote the collection of p-predictor variables of $\mathbf{Y}$, where

$$\boldsymbol{X} = \begin{bmatrix} 1 & x_{11} & \dots & x_{1p} \\ 1 & x_{21} & \dots & x_{2p} \\ .. & \dots & \dots & \dots \\ 1 & x_{n1} & \dots & x_{np} \end{bmatrix}$$

is called regression matrix and without the leading column of 1s is termed as predictor data matrix. Then, the conditional probability that a household head is food insecure given the $\mathbf{X}$ set is denoted by $P(y_i = 1/\mathbf{X}) = p_i = p(\mathbf{X})$. The expression $p(\mathbf{X})$ has the form:

$$p_i = p(\mathbf{X}) = P[y_i = 1/\mathbf{X}] = \frac{e^{(\beta_0+\beta_1\mathbf{X_1}+\beta_2\mathbf{X_2}+.....+\beta_p\mathbf{X_p})}}{\mathbf{1}+e^{(\beta_0+\beta_1\mathbf{X_1}+\beta_2\mathbf{X_2}+.....+\beta_p\mathbf{X_p})}} = \frac{e^{\mathbf{X}\boldsymbol{\beta}}}{1+e^{\mathbf{X}\boldsymbol{\beta}}} = \frac{1}{1+e^{-\mathbf{X}\boldsymbol{\beta}}} \quad \dots\dots\dots(1)$$

where p_i stands for the probability of household i being food insecure, y_i is the observed food insecurity status of household i, $\boldsymbol{\beta} \sim (\mathrm{p}+1)\times 1$ is a vector of unknown coefficients. Equation (1) is called Multiple Logistic Regression Model. The logarithmic transformation of equation (1) yields the Logit Regression Model which is given as:

$$\log it[p(X)] = \ln \frac{p(\mathbf{X})}{1-p(\mathbf{X})} = \mathbf{X\beta} = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + ... + \beta_p x_{ip}$$

3.5 Parameter Estimation

The maximum likelihood and non-iterative weighted least squares are the two most competing estimation methods used in fitting logistic regression model (Hosmer-Lemeshow, 1989; Greene, 1991, Collet, 1991 and others). When the assumption of normality of the predictors does not hold, the non-iterative weighted least squares method is less efficient (Maddala, 1997). In contrast, the maximum likelihood estimation method is appropriate for estimating the logistic (logit) model parameters due to this less restrictive nature of the underlying assumptions (Hosmer-Lemeshow, 1989). Hence, in this study the maximum likelihood estimation technique was applied to estimate parameters of the model.

Consider the logistic model $p_i = \frac{e^{\mathbf{X\beta}}}{1+e^{\mathbf{X\beta}}}$. Since observed values of $\mathbf{Y}$ say, $y_i's$ $(i = 1,2,...,n)$ are independently distributed as binomial with parameter p_i , $y_i \sim bin(1, p_i)$, the likelihood function of $\boldsymbol{Y}$ is given by:

$$\ell(\mathbf{\beta}, \mathbf{Y}) = \prod_{i=1}^{n} p_i^{y_i}(1-p_i)^{1-y_i} = \prod_{i=1}^{n} \left[\frac{e^{X\beta}}{1+e^{\mathbf{XB}}}\right]^{y_i} \left[\frac{1}{1+e^{\mathbf{XB}}}\right]^{1-y_i} \quad \text{..................................(2)}$$

Our objective is then to get an estimator $\hat{\boldsymbol{\beta}} = (\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_p)$ of $\mathbf{\beta}$ which maximizes the likelihood function expressed in equation (2). Since the likelihood equations are non-linear in the parameters, the Newton-Raphson iterative maximum likelihood estimation method that expresses $\hat{\beta}$ at the $(u+1)^{th}$ cycle of the iteration is expressed as $\hat{\beta}_{u+1} = \hat{\beta}_u + (X'\hat{V}_u X)^{-1} XR_u$ where u=0,1,2,3,…… and $\hat{V}$ is a diagonal matrix with its diagonal elements $\hat{V} = diag[\hat{p}_i(1-\hat{p}_i)] = Cov(\mathbf{Y})$. Finally, $\hat{\beta}$ is the resultant maximum likelihood estimator of β with residual $R = Y - \hat{P}$ (Collet, 1991; Greene, 1991). Newton's method usually converges to the maximum of the log-likelihood in just a few iterations unless the data are especially badly conditioned (Greene, 1991). All the parameters $\hat{\beta}_0, \hat{\beta}_1, ..., \hat{\beta}_p$ and estimates of $P[y_i = 1/X]$ for each subject were computed using the SPSS software.

Once the conditional probabilities have been calculated for each household, the "partial" effects of the discrete variables were calculated by taking the difference of the mean probabilities estimated for the respective discrete variable $(x_i = 0, \; x_i = 1)$.

3.5.1. Interpretation of the Coefficients of the Logistic Regression Model

The estimated coefficients for the predictor variables represent the slope or rate of change of a function of the outcome variable per unit of change in the predictor variable (Hosmer-Lemeshow, 1989). Thus interpretation involves two issues: (i) determining the functional relationship between the outcome variable and the predictor variable and (ii) appropriately defining the unit of change for the predictor variable (Hosmer-Lemeshow, 1989).

The estimated logistic coefficients $\hat{\beta}_j's$ reflect linear and non-linear relationships and they will be interpreted as the change in the log-odds for every unit increase/decrease (depending on the variable change in x_j) holding other predictors constant. Hence, the odds of being in the category of interest for the i^th subject, denoted by $e^{\hat{\beta}_j} = \hat{p}_i / (1 - \hat{p}_i)$ where i=1,2,3,…,n and j=1,2,3,…,p, represents the multiplicative factor by which the odds change for every u-units change in x_j controlling for the other predictor variables. For predictor variables having L levels $(L \geq 2)$, interpretation was made by making one of the L-levels as a reference category. Accordingly, the study uses SPSS version 13 software and the coding of the dependent and predictor variables is described as follows with the reference group denoted by Ref.

Dependent Variable Encoding

Original Value	Internal Value
0, food secure	0
1, food insecure	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
AGE	1, <=29	48	1.000	.000	.000
	2, 30-36	56	.000	1.000	.000
	3, 37-47	46	.000	.000	1.000
	4, >=48 (Ref.)	32	.000	.000	.000
SEX	1, female	49	1.000		
	0, male (Ref.)	133	.000		
FSIZE	1, ≥ 6	145	1.000		
	0, ≤ 5 (Ref.)	37	.000		
YIELD	1, < 712.59 kg	131	1.000		
	0, ≥ 712.59 kg (Ref.)	51	.000		
LSIZE	1, < 0.381 hectare	131	1.000		
	0, ≥ 0.381 hectare (Ref.)	51	.000		
TEC	1, non-adopter	122	1.000		
	0, adopter (Ref.)	60	.000		
AID	1, good	126	1.000		
	0, not-good (Ref.)	56	.000		
TENURE	1, not confident	150	1.000		
	0, confident (Ref.)	32	.000		
EDUC	1, cannot read and/or write	100	1.000		
	0, can read and write (Ref.)	82	.000		
TLU	1, < 2.678 TLU	117	1.000		
	0, ≥2.678 TLU (Ref.)	65	.000		
OFFARM	1, did not participate	149	1.000		
	0, participated (Ref.)	33	.000		

Odds, odds ratios and logits are all important basic terms in logistic regression. Parameter estimates ($\hat{\beta}$ coefficient) are logits of explanatory variables used in logistic regression equation to estimate the log-odds that dependent equals 1 (binomial logistic regression). Odds ratio above 1 refers to the odds that dependent equals 1 in binary logistic regression. The closer the odds ratio is to unity, the more the predictor variable's categories are independent of the outcome variable, with 1 representing full statistical independence.

3.6 Variable Selection and Goodness-of-fit Assessment of Model

3.6.1. Variable Selection and Test for a Single Predictor

The number of variables that would be included in the model should be of the minimum possible that is parsimonious and deliver optimum information. In this study the variable selection process begins with a univariate analysis of each variable. A systematic relation or association between each predictor variable with the response variable was made before the final model was selected. A univariate logistic regression and a likelihood ratio (LR) chi-square test (for a 2xL contingency table) were also employed to examine the importance of each predictor variables to the outcome variable.

The separate effects of each predictor variable in explaining the outcome variable was made by postulating the null hypothesis that $\mathrm{H}_0 : \beta_i = 0$ against the alternative $\mathrm{H}_1 : \beta_i \neq 0$ for at least on i=1,2,…,n. The significance test for each coefficient in the model was done using Wald chi-square ($\left[\hat{\beta} \big/ s.e(\hat{\beta}) \right]^2$ which is distributed as chi-square with 1 degrees of freedom) and Likelihood Ratio Test. The Wald statistic, however, has some undesirable properties for large coefficients as standard error is inflated lowering the Wald statistic (chi-square) value and leading to type II errors. On other hand, Agresti (1996) suggested that the likelihood ratio (LR) test is more reliable for small sample sizes than the Wald test. Accordingly, this study used the Wald and/or LR statistic to assess the significance of each predictor variables.

Upon completion of the univariate analysis, predictor variables for the multivariate analysis were selected with a condition that any variable whose univariate test has a p-value less than 0.25 was considered as a candidate for the multivariate model along with all variables of known socio-demographic or economic importance (Hosmer-Lemeshow, 1989). Besides, when cross-classified with outcome variable, any predictor variable with zero cell frequency was handled by collapsing the categories of the predictor variables in some sensible manner to eliminate the zero cell or eliminating the category completely; or if the variable is ordinal scaled, modeling the variable as if it were continuous (Hosmer-Lemeshow, 1989). In order to determine the number of predictor variables to be considered in a study, some literature suggest that there should be 50 cases for each predictor while others recommend 10 cases per predictor. In general, there should be significantly fewer independents than the ordinary least squares regression as logistic dependents, being categorized have lower information content. In this regard, a rule of thumb is that there should be no more than one independent for each 10 cases in the sample. In applying this rule of thumb, if there are categorical independents such as dichotomous, the number of cases should be considered to be the lesser of the groups. Accordingly, this study considered a rule of thumb of 10 observations for each predictor variable included in the study.

For multivariate model, a stepwise method in which variables are selected either for inclusion or exclusion from the model in a sequential fashion based solely on statistical criteria was used. There are two main versions of the stepwise procedure: (a) forward selection with a test for backward elimination and (b) backward elimination followed by a test for forward selection. The study employed stepwise forward likelihood ratio procedure in order to select the list of predictor variables that will have joint impact in influencing the outcome variable.

The final decision on the inclusion of each predictor variable was made on the examination of the Wald statistic for the variable, and comparing each estimated coefficient of the particular variable on the multivariate regression model with the univariate estimate of the model containing only that predictor. Variables that do not contribute to the model based on these criteria were eliminated and a new model was fit. The new model was compared with the old model through the LR test. Also, the estimated coefficients for the remaining variables were compared to those from the full model. In view of this (deletion, refitting and/or verifying) was performed. Having obtained a model that contained the essential variables, the need to include interaction term in the model was assessed by creating the appropriate product of the variables in question. Assessment of the significance of each interaction term was made using a LR test. Interactions that did not contribute to the improvement of the model were discarded and the model with main-effects was maintained.

3.6.2. Goodness-of-fit Assessment of the Model

A variety of statistical tests exist for determining the significance or goodness-of-fit of a logistic regression model. These measures include: Deviance; Pearson; Likelihood Ratio Test; Hosemer-Lemeshow Goodness-of-Fit Test (assesses the fit of the model by comparing the observed and expected frequencies); and Nagelkerke Pseudo R^2. Goodness of fit of the model can also be assessed by considering how well the model classifies the observed data (in the Classification Table) or examining how “likely” the sample results actually are, given the estimates of model parameters (SPSS, 1994). In this regard, examination of the confusion matrix by modifying the threshold value whenever necessary will help to analyze the overall performance of the model. The fit is considered to be good if the overall correct classification rate exceeds 50%. According to Collet (1991), the choice of a suitable threshold value is made either by identifying the value that minimizes the overall proportion of misclassification or by compromising between the minimization of the two misclassification probabilities, namely the probability of declaring an individual to be in group 0 (food secure) when it should be in group 1 (food insecure) and vice versa. The study used the default threshold cut value of 0.5 which was set by SPSS software.

The computed value of likelihood ratio (LR) test, which is defined as $-2[L_0 - L_1]$ (where L_0 and L_1 are the maximized log-likelihoods under the null and alternative hypothesis, respectively) was used to test the null hypothesis that the p-coefficients for the covariates in the model are not important in explaining the response variable against the alternative that at least one of the covariates is important. Under the null hypothesis, the LR is distributed as $\chi_p^2(\alpha)$ and hence if LR exceeds that of $\chi_p^2(\alpha)$, we reject the null hypothesis and conclude that at least one of the p-covariates included in the model are important in explaining the variation in the outcome variable.

Similarly, the null hypothesis that the model fits the data against the alternative that the model does not fit was tested using Hosemer-Lemeshow Test. A non-significant Hosemer-Lemeshow means that the observed and predicted counts are close to each other and the model describes the data well. Besides, if Omnibus test of model coefficients is significant, it implies that the model fits the data adequately.

3.7 Model Adequacy

Once a model is fitted to the observed values of a binary response variable, a thorough examination of the extent to which the fitted model provides an appropriate description of the observed data is a vital aspect of modeling process. The fitted logistic regression model may be inadequate due to a particular observation, termed **outliers**, or observations, termed **influential** values that have an undue impact on the conclusions to be drawn from the analysis and presence of complete or near compete linear dependencies among the predictor variables. Some of the statistical techniques which are employed to examine the adequacy of a fitted model include: detection and treatment of outliers, influence and multicollinearity diagnostics.

3.7.1 Detection and Treatment of Outlier(s)

Observations that are surprisingly distant from the remaining observations in the sample are called outlying values or **outliers.** Such values may occur as a result of measurement errors, employing a faulty experimental procedure or just an extreme manifestation of natural variability. For binary data, an outlier occurs as a result of **transcription errors,** that is, when the response variable equals unity and the corresponding fitted probability is near zero or vice versa (Collet, 1991). Since fitted probabilities near zero or one will occur when the linear predictor has a large negative or a large positive value, outliers can only occur at observations that have extreme values of the explanatory variables.

Some of the statistical methods that were used for detecting the presence and extent of influence of outlier(s) were: unstandardized residuals, $y_i - \hat{p}_i$; the Pearson or standardized $\chi^2 = \sum_{i=1}^{n} \frac{(y_i - \hat{p}_i)^2}{\hat{p}_i (1-\hat{p}_i)}$ residuals (the change in model deviance if the case is removed) and deviance (D) which is defined as $\pm 2\sqrt{\ln\left[\frac{y_i}{\hat{p}_i}\right]^{y_i}\left[\frac{1-y_i}{1-\hat{p}_i}\right]^{1-y_i}}$. Of these methods, the study employed the standardized residuals for identifying potential outliers. Hence, using the customary significance level of 0.01, the presence of outliers was signaled if the standardized or Pearson residuals lie outside the range of the interval (-3, +3).

Whenever outliers are identified, their effect on the results of the analysis can be assed by re-analyzing the data after omitting them. If essentially the same inferences are drawn from the data both with and without the outliers, one need not be concerned about their presence. On the other hand, if the outliers do affect model-based inferences, the decision on how to regard them (to include them, to revise the model or to omit them) should not only be made on statistical grounds but also through closer subjective and objective examination of the data and its other essential ingredients.

3.7.2 Influence Diagnostics

An observation is said to be influential if its omission from the data set results in substantial changes to certain aspects of the fit of the linear logistic regression model. In most cases, it is more important to pay attention on outliers that are influential than those that are not. Although outliers may also be influential observations, an influential observation need not necessarily be an outlier. In particular, an influential observation that is not an outlier will occur when the observation distorts the form of the fitted model to such an extent that the observation itself has a small residual.

Some of the statistical methods used in influence diagnostics are: Leverage statistic; ($\hat{h}_{ii}$, which is called the diagonal elements of the matrix $H = X(X'X)^{-1}X'$ with diagonal elements of $\hat{p}_i(1-\hat{p}_i)$, called the "hat" matrix); DFBETA (the change in the logistic regression parameter estimates when the observation is deleted); Cook's distance ($C_i = \frac{r_i\hat{h}_{ii}}{p(1-\hat{h}_{ii})}$ where r_i is the Pearson residual, $\hat{h}_{ii}$ the leverage of case i and p the number of parameters in the model); and the change in the Pearson statistic ($\chi^2 = \sum_{i=1}^{n}\frac{(y_i-\hat{p}_i)^2}{\hat{p}_i(1-\hat{p}_i)}$ or goodness-of-fit statistics (-2log-likelihood)).

The study used Cook's distance to assess the overall impact of an observation on the estimated parameter vector $\hat{\boldsymbol{\beta}}$. Hence, points for which Cook's distance greater than one was considered as influential. Besides, the specific impact of an observation on the regression coefficients was checked using the DFBETA statistic. DFBETA greater than unity was considered as outlier(s) for critical variables in the model,

3.7.3 Multicollinearity

Multicollinearity in logistic regression is a result of strong correlations between independent variables. Maddala (1997) described that high inter-correlations among the predictor variables by themselves need not necessarily cause any problems in inference. Whether or not this is a problem will depend on the magnitude of the error variance and the variances of the predictor variables. Multicollinearity may be induced due to poor sampling method, misspecification and overfitting of a model as well as improper use of dummy variables.

Some of the statistical techniques that have been proposed for detecting multicollinearity among categorical predictor variables are: inspecting off-diagonal elements of the Kendall's tau bivariate correlation matrix of the explanatory variables; variance inflation factors (VIFs), tolerance and condition number or indices. Examining the Kendall's tau bivaraite correlations between the predictors (say x_i and x_j for $i \neq j$) and looking for "big" values of r_{ij} equals 0.8 and above could help detecting high multicollinearity. The problem, however, with this method is that one predictor may be a linear combination of several predictors, and yet not be highly correlated with any one of them. Besides, it is hard to decide on a cutoff point particularly the smaller the sample, the lower the cutoff point should probably be.

Marqurdt (1970) described that tolerances or variance inflation factors (VIFs) are probably superior to the analysis based on bivaraite correlations and defined as $VIF(\hat{\beta}_j) = \frac{1}{1-R_j^2}$ where, R_j^2 is the coefficient of determination obtained when x_j is regressed on the remaining $p-1$ predictors. The VIF for each term in the model measures the combined effect of the dependencies among the predictors on the variance of that term. A commonly given rule of thumb is that if any of the VIFs exceeds 5 or 10, it is an indication that the associated regression coefficients are poorly estimated because of multicollinearity. Another approach is taking the inverse of VIF termed as tolerance associated with a predictor. When the tolerance is small, say less than 0.01 then, it would be expedient to discard the variable with smallest tolerance. A tolerance close to 1 means there is little multicollinearity; whereas a value close to zero suggests that multicollinearity may be a threat. Condition number, which is defined by maximum eigenvalue of $X'X$ divided by smallest eigenvalue and condition indices are also used to flag excessive collineraity in the data. Condition number between 100 and 1000 implies moderate to strong multicollineraity (Montgomery and Peck, 1992). This study used Kendall's tau bivaraite correlations, tolerance, VIFs and condition number or indices to assess the extent of multicollinearity.

3.8 Reliability Analysis

Reliability is the correlation of an item, scale, or instrument with a hypothetical one which truly measures what it is supposed to. Since the true instrument is not available, reliability can be estimated using Cronbach Alpha Coefficient, Kuder Richardson

Formula or Split-Half Reliability Coefficient to check for internal consistency within a single test. Cronbach Alpha can be used for both binary-type and large-scale data and is the most common form of internal consistency reliability coefficient, which is based on the average correlation among items. Alpha equals zero when the true score is not measured at all and hence there is only an error component. Alpha equals one when all items measure only the true score and there is no error component. Cronbach's Alpha can be interpreted as the percent variance the observed scale would explain in the hypothetical true scale composed of all possible items in the universe. Alternatively, it can be interpreted as the correlation of the observed scale with all possible other scales measuring the same thing and using the same number of items.

Cronbach Alpha procedure returns two coefficients: raw and standardized. The raw coefficient is based on item correlation implying that the stronger the items are inter-related, the more likely the test is consistent. The standardized coefficient is based on covariance indicating the higher the correlation coefficient is, the higher the covariance. The higher the Alpha is, the more reliable the test is. There is not a generally agreed cut-off. Usually 0.7 and above is acceptable (Cronbach, 1951). It is a common misconception that is Alpha is low; it must be a bad test. This is because the test may measure several attributes/dimensions rather than one and thus the Conbach Alpha is deflated. By convention, a lenient cut-off of 0.60 is common in exploratory study (Cronbach, 1951) and some researchers require a cut-off of 0.80 for a "good scale". As a general rule of thumb (Shoukri and Edge, 1996), a reliability coefficient alpha is excellent if Alpha is larger than 0.75; good if Alpha is between 0.40 and 0.74 and poor if Alpha is less than 0.40.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Descriptive Results

Based on the recommended daily food intake of 2,100 kilo calorie, it was observed that 69.2% of the sampled households of the *Woreda* were food insecured while 30.8% were food secure. Summary statistics of selected predictor variables are presented in Table 1.

Table 1. Summary statistics of selected predictor variables

i	Variables	Household Food Security Status				Test statistic (z)
		Food Secure (sample size, $n_1 = 56$)		Food Insecure (sample size, $n_2 = 126$)		
		Mean $\bar{x}_{1i}$	Std. dev. s_{1i}	Mean $\bar{x}_{2i}$	Std. dev s_{2i}	
1	Age of household head (years)	38.46	11.01	38.34	11.70	0.067
2	Family size (number)	4.24	1.52	7.34	1.75	–12.109*
3	Annual yield (kilogram)	892.17	372.03	308.52	137.53	11.399*
4	Farm land size (hectares)	0.53	0.51	0.05	0.04	7.069*
5	Tropical Livestock Unit (TLU)	3.18	1.17	1.56	0.97	9.086*
6	Annual income (Birr)	3,104.84	752.78	2,621.63	687.55	4.103*
7	Per capita daily caloric availability (kilo calorie)	3,020.52	766.32	1,326.62	402.91	15.610*
	Shortfall/surplus index (P)	0.44		0.37		-
	Head count ratio (H)	0.31		0.69		-

* Statistically significant at 0.05 level of significance

Test of significant difference between the food secure and insecure groups of households was made regarding the respective variables as summarized in Table 1. Accordingly, with the 0.05 level of significance, the z-test result shows that there is a significant difference in family size, annual production, TLU, annual income and per capita daily caloric availability between the food secure and food insecure groups of households. On the other hand, there was no significant difference in the age of food secured and food insecured household heads.

From the results presented in Tables 1, the study area could be regarded as food insecure given the fact that only 31% of the households were able to meet the recommended calorie intake of 2,100 kilo calorie per capita per day, while 69% could not. The surplus/shortfall indices (P) of 0.44 and 0.37 indicate that food secure households exceeded the calorie requirement by 44% and the food insecure households felt short of the calorie requirement by 37%, respectively. The mean age of household both for food secure and insecure household heads is 38 years with standard deviation of 11 years. On average food secure households have four family members with standard deviation of 1.52 while food insecure households have seven members with standard deviation of 1.75. During the period under study, food secure households produced on average 892.17 kilogram cereals with standard deviation of 372.03 kilogram while food insecure households produced 308.52 kilogram with standard deviation of 137.53 kilogram. The average farm land size of food secure households is 0.53 hectares while food insecure households have only 0.05 hectares. Food secure households have 3.18 tropical livestock unit (TLU) on average, while food insecure households have 1.56 TLU, which is half of what food secure households have. The average annual income of food secure and food insecure households was 3,104.84 and 2,621.63 Birr, respectively.

4.2 Univaraite Results

The systematic association between each predictor variables and household food security status was conducted by cross-tabulating each predictor variables against the outcome variable. In addition, a univaraite logistic regression of each predictor variable against the household food security status was performed to select the significant candidate predictor variables that would qualify for the multivariate logistic regression model.

Table 2. Association between household food security status and selected predictor variables in Tehuludere *Woreda*.

Variables	n	Total %	Food secure %	Food insecure %	Pearson Chi-square	LR	d.f
OFFARM							
didn't participate	149	81.9	18.8	81.2	55.341	52.613	1
participated	33	18.1	84.8	15.2	(0.000)	(0.000)	
SEX							
female	49	26.9	22.4	77.6	2.179	2.266	1
male	133	73.1	33.8	69.8	(0.140)	(0.132)	
FSIZE							
≥ 6	145	79.7	17.9	82.1	55.186	52.382	1
≤ 5	37	20.3	81.1	18.9	(0.000)	(0.000)	
YIELD							
< 712.59	131	72	19.8	80.2	26.179	25.023	1
≥ 712.54	51	28	58.8	41.2	(0.000)	(0.000)	
LSIZE							
< 0.38	131	72	19.1	80.9	29.966	28.657	1
≥ 0.38	51	28	60.8	39.2	(0.000)	(0.000)	
TEC							
non-adapter	122	67	19.7	80.3	21.394	20.784	1
adopter	60	33	53.3	46.7	(0.000)	(0.000)	
AID							
good	126	69.2	23	77	11.556	11.169	1
not good	56	30.8	48.2	51.8	(0.001)	(0.001)	
TLU							
< 2.68	117	64.3	17.1	82.9	28.760	28.297	1
≥ 2.68	65	35.7	55.4	44.6	(0.000)	(0.000)	
EDUC							
cannot read and/or write	100	54.9	29	71	0.326	0.326	
can read and write					(0.568)	(0.568)	1
	82	45.1	32.9	67.1			
TENURE							
insecure	150	82.4	25.3	74.7	11.834	11.026	1
secure	32	17.6	56.3	43.8	(0.001)	(0.001)	
AGE							
≤ 29	48	26.4	35.4	64.6			
30-36	56	30.8	25	75	16.338	16.201	3
37-47	46	25.3	15.2	84.8	(0.001)	(0.001)	
≥ 48	32	17.6	56.3	43.8			

The results in Table 2 indicate that the proportion of food insecure households is higher among households who did not participate in off-farm income earning activities (81.2%). The proportion of food insecurity is higher among households led by women (77.6%). The proportion of food insecurity is higher among households with family size larger than sample mean (82.1%). The proportion of food insecure households is 80.2% and 80.9% among households who have yearly grain production less than the sample average yield and farm size less than the average of the sample households. Food insecurity was higher among non-adapters of agricultural technology (80.3%) and households who have dependency feeling on food aid (77%). Of the food insecure households, 82.9% have smaller tropical livestock unit (less than the sample average 2.68 TLU). Food insecurity was higher among households who have no educational background (can not read and/or write) (71%) and those who have insecure land tenure feeling (74.7%). About 85% of food insecure households are found in the age range between 37 to 47 years.

The chi-square and likelihood Ratio (LR) test results presented in Table 2 were also used to test whether or not there is a systematic association between food security status and each predictor variables. These tests revealed that except SEX and EDUC, all other predictor variables showed a significant positive association with household food insecurity. Apart from the cross-classification table that displays the percentage, chi-square and likelihood ratio test results, a univariate logistic regression model was fitted with its results presented in Table 3.

Table 3. Univariate logistic regression result

Predictor Variable	Coeff. (β)	S.E.	Wald	d.f	Sig.	*Exp*(β)	90% C.I. for *Exp*(β)	
							Lower	Upper
OFFARM (1)	3.186	0.529	36.300*	1	0.000	24.200	10.140	57.757
SEX (1)	0.569	0.388	2.147	1	0.143	1.767	0.933	3.346
FSIZE (1)	2.976	0.472	39.714*	1	0.000	19.615	9.020	42.656
YIELD (1)	1.753	0.359	23.821*	1	0.000	5.769	3.196	10.414
LSIZE(1)	1.883	0.363	26.919*	1	0.000	6.572	3.618	11.938
TEC (1)	1.540	0.345	19.969*	1	0.000	4.667	2.647	8.227
AID (1)	1.136	0.341	11.094*	1	0.001	3.114	1.777	5.457
TLU (1)	1.795	0.350	26.293*	1	0.000	6.021	3.385	10.709
EDUC (1)	0.184	0.322	0.326	1	0.568	1.202	0.708	2.042
TENURE (1)	1.332	0.403	10.940*	1	0.001	3.789	1.954	7.350
AGE			14.973*	3	0.002			
AGE (1)	0.582	0.467	3.330*	1	0.004	2.345	1.088	5.054
AGE (2)	1.35	0.471	8.200*	1	0.000	3.857	1.776	8.376
AGE (3)	1.969	0.544	13.120*	1	0.481	7.163	2.930	17.515

* statistically significant at $p < 0.005$

Results in Tables 3 indicate that the Wald statistics for each of OFFARM, FSIZE, YIELD, LSIZE, TEC, AID, TLU, TENURE and AGE were positively related with the household food security status and were also statistically significant. This means separate effect of each of these predictors on household food security status was significant. On the other hand, the predictor variables SEX and EDUC showed the expected sign implying that women headed households are more food insecure than male-headed households. The positive sign of EDUC shows that the probability of food insecurity is high for household heads who could not read and/or write. However, both SEX and EDUC were statistically insignificant even at 0.10 level. Hence, taking into account their known socio-demographic importance to the study and assessing their univaraite test, the predictor variable SEX was the only one that had p-value of 0.143 which was less than 0.25. The cross-tabulation analysis of SEX with food security status and EDUC with food security status also indicated that there is no systematic association between each of SEX and EDUC with the outcome variable. Therefore, SEX was selected together with the other significant predictors for inclusion in the multivariate logistic regression model.

Hence, on the basis of the univariate results, the list of predictor variables that were considered as candidates for multivariate logistic regression model were OFFARM, SEX, FSIZE, YIELD, LSIZE, TEC, AID, TLU, TENURE and AGE.

4.3 Multivariate Logistic Regression Results

Based on the results of univariate analysis, a model containing 10 selected predictor variables and some selected interaction terms were included in the multivariate analysis. Using the stepwise (likelihood ratio) method, seven out of ten predictor variables were selected and have a significant joint impact in determining household food insecurity. The multivariate logistic regression result is summarized in Table 4.

Table 4. Multivariate logistic regression result

	Coeff. (β)	S.E.	Wald	df	Sig.	Exp(β)	90.0% C.I.for EXP(β)	
							Lower	Upper
OFFARM(1)	2.016	.710	8.064	1	.005	7.509	2.336	24.144
FSIZE(1)	1.541	.642	5.755	1	.016	4.670	1.623	13.436
YIELD(1)	1.206	.513	5.525	1	.019	3.341	1.436	7.771
LSIZE(1)	1.091	.525	4.311	1	.038	2.976	1.254	7.061
AID(1)	.996	.504	3.895	1	.048	2.706	1.180	6.205
TLU(1)	1.280	.495	6.688	1	.010	3.598	1.594	8.124
TENURE(1)	1.219	.592	4.247	1	.039	3.384	1.279	8.954
Constant term	–5.882	1.004	34.306	1	.000	.003		

The Omnibus tests of models coefficients had a chi-square value of 53.68 on 7 degrees of freedom, which is highly significant beyond 0.001 level indicating that the predictor variables presented in Table 4 have a joint significant importance in predicting household food security status. The model chi-square value was 53.684 on 7 degrees of freedom and was highly significant beyond 0.005 level indicating that the inclusion of the explanatory variables contributed to the improvement in fit of the full model as compared to the constant only model. The Cox and Snell and Nagelkerke pseudo R-square values of the model were 0.442 and 0.6244, respectively. The Hosmer-Lemeshow test result reported chi-square value of 9.737 with p-value of 0.204 on 7 degrees of freedom. But this p-value is greater than the 0.10 and 0.05 levels showing that there is no difference between the observed and the model predicted values and hence estimates of the model fit the data at an acceptable level. Assessment of the interaction terms showed that none of them were statistically significant and hence were excluded from the model.

With regard to the predictive efficiency of the model, Table 5 shows that of the 182 sample households included in the model, 159 (87.4%) were correctly predicted. The sensitivity and specificity indicate that 91.3 % of food insecure and 78.6% of food insecure households were correctly predicted in their respective categories. With regard to the error rates committed in the classification table, the false positive rate (the number of errors where the dependent is predicted to be food insecure, but is in fact food secure) is 21.4% while the false negative rate (the number of errors where the dependent is predicted to be food secure, but is in fact food insecure) is 8.7%.

Table 5. Classification table

Observed	Predicted		Percentage Correct
	Food Secure	Food Insecure	
Food Secure	44	12	78.6
Food Insecure	11	115	91.3
Overall percentage			87.4

In general, the goodness-of-fit assessment of the multivariate logistic regression model implied that the model fits the data well. The adequacy of the fitted model was checked for possible presence and treatment of outliers, influential values and multicollinearity. The diagnostic test results for detection of outliers and influential values are presented in Table 6.

Table 6. Results of diagnostic tests for outliers and influential values

	Minimum	Maximum
Normalized Residuals	-2.46262	1.72041
Cook's Influence Statistics	0.00007	0.42402
DFBETA for Constant	-0.17375	0.32013
DFBETA for OFFARM	-0.30887	0.22280
DFBETA for FSIZE	-0.27032	0.29148
DFBETA for YIELD	-0.12819	0.16982
DFBETA for LSIZE	-0.14773	0.20085
DFBETA for AID	-0.12626	0.12752
DFBETA for TLU	-0.12535	0.12384
DFBETA for TENURE	-0.12481	0.15957

The minimum and maximum values of the test results were presented in Table 6. The table shows that the normalized residuals are within the interval of -3 and 3 implying that no outliers were detected at 0.01 level of significance. The DFBETAs for model parameters including the constant term and Cook's influence statistics were both less than unity. DFBETAs less than unity implies no specific impact of an observation on the coefficient of a particular predictor variable while Cook's distance less than unity showed that an observation had no overall impact on the estimated vector of regression coefficients $(\hat{\boldsymbol{\beta}})$. The multicollineairty diagnostics test was conducted using condition number or indices, tolerance, VIFs and Kendall's correlation matrix of the predictor variables, which are summarized in Table 7.1 and Table 7.2 as follows.

Table 7.1 Results of colinearity statistics

Model Coefficients	Colinearity Statistics			
	Eigenvalue	Condition Index	Tolerance	VIF
OFFARM	3.423	1.000	0.545	1.834
TENURE	0.960	1.889	0.834	1.199
FSIZE	0.690	2.228	0.576	1.736
TLU	0.615	2.359	0.849	1.178
YIELD	0.555	2.484	0.874	1.144
LSIZE	0.481	2.667	0.825	1.212
TEC	0.276	3.525	0.847	1.181
Condition Number = 12.402				

As Table 7.1 shows, all of the tolerance values are close to unity and none of the VIFs exceed 5 implying that multicollinearity may not be a cause of concern. The condition number 12.402 indicates no serious problem with multicollinearity. Looking at the Kendall's correlation matrix of Table 7.2, none of the bivariate correlations between any two predictor variables exceeded 0.8 indicating that multicollinearity is not a serious problem among the categorical predictor variables.

Table 7.2. Kendall's tau_b correlation matrix

	OFFARM	FSIZE	YIELD	LSIZE	AID	TLU	TENURE
OFFARM	1.000	0.613	0.310	0.278	0.181	0.274	-0.068
FSIZE	0.613	1.000	0.232	0.262	0.225	0.279	0.125
YIELD	0.310	0.232	1.000	0.156	0.141	0.199	0.097
LSIZE	0.278	0.262	0.156	1.000	0.114	0.275	0.226
AID	0.181	0.225	0.141	0.114	1.000	0.025	0.067
TLU	0.274	0.279	0.199	0.275	0.025	1.000	0.138
TENURE	-0.068	0.125	0.097	0.226	0.067	0.138	1.000

As far as the in internal consistency reliability of the data used in the study is concerned, Cronbach alpha coefficient of 0.628 is obtained. This value is an estimate and a lower bound for true reliability of the sample survey. Using a rule of thumb suggested by Shoukri and Edge (1996), the Alpha coefficient of 0.628 suggests that the data used in the study has a good internal consistency reliability coefficient. This means on the average, household heads have similar opinions or judgment towards considering the 7 items or variables (OFFARM, FSIZE, YIELD, LSIZE, AID, TLU and TENURE) as major determinants of food insecurity. .

4.4 Discussion

The signs of the regression coefficients of the final model (Table 4) fulfill the underlying assumption and the corresponding Wald statistics or p-values less than 0.01 imply that the seven predictor variables included in the multivariate model have a significant joint influence on the outcome variable. The univariate analysis results also confirms that each of the seven predictor variables have the expected sign and are also statistically significant in influencing household food insecurity.

Accordingly, households who did not participate on off-farm activities are eight times as likely to be food insecure relative to those who participated. Household heads that have larger family size (larger than the sample mean) are almost five times as likely to be food insecure than those who have smaller family members (less than the sample mean). Household heads whose own annual production is low (less than the sample mean) are almost three times as likely to be food insecure relative to those who have higher annual production (higher than the sample mean). The odds of land size is 2.976 implying that household heads who have smaller land size (less than the sample mean land size) are almost three times as likely to be food insecure than those having bigger land size (bigger than the sample mean land size). Household heads who have dependency attitude on food aid are almost three times as likely to be food insecure than those who do not. The tropical livestock unit, which was used as a proxy to measure wealth status of household has odds of 3.598 implying that a household head whose wealth status is poor (less than the sample mean TLU) is four times as likely to be food insecure relative to those whose wealth status is good(greater than the sample mean TLU). Household heads with unsure land tenure perceptions are three times as likely to be food insecure as those who have confident land tenure attitude.

The result of the marginal effects of significant discrete predictor variables on the probability of household food insecurity is summarized in Table 8 below.

Table 8. Change in probabilities between X_i=1 and X_i=0 for significant discrete determinants.

Determinants		Probabilities	Change in Probabilities
OFFARM			
	did not participate	0.81	-0.66
	participated	0.15	
FSIZE			
	≥ 6 member	0.82	-0.63
	≤ 5 member	0.19	
YIELD			
	< 712.59 kg	0.80	-0.39
	≥ 712.59 kg	0.41	
LSIZE			
	< 0.38 hectare	0.81	-0.42
	≥ 0.38 hectare	0.39	
AID			
	good	0.77	-0.25
	not-good	0.52	
TLU			
	< 2.68 TLU	0.83	-0.38
	≥ 2.68 TLU	0.45	
TENURE			
	not confident	0.75	-0.31
	confident	0.44	

According to Table 8, among the seven discrete determinants, a significant change in probabilities was observed by a shift from non-participation of off-farm activities to participation which resulted in decreasing the probability of household food insecurity from by 66%. A shift from having larger family members (larger than the sample mean) to smaller family members (smaller than the sample mean) decreases the probability of household food insecurity by 63%. A shift from low yield (less than the sample mean yield) to high yield (larger than the sample mean yield) will decrease the probability of household food insecurity by 39%. A shift from smaller farm land size (smaller than the sample mean land size) to larger farm size (larger than the sample mean land size) will decrease the probability of household food insecurity by 42%. A shift from dependency attitude on food aid to self-reliance decreases the probability of household food insecurity by 25%. A shift to annual yield of greater than the mean value will decrease household food insecurity by 38%. An improvement in household head’s land tenure security defined by a shift from tenure insecurity (not confident) to tenure security (confident) decreases the probability of household food insecurity by 31%.

4.5 The Impact of Significant Determinants on the Probability of Household Food Security

The level of probability due to changes in statistically significant predictor variables was also conducted with reference to a base group of households representing food insecure households. The base group represents food insecure households with an average family size of 7.34 members; average cereal yield of 308.52 kilogram; average farm land size of 0.05 hectares; average tropical livestock unit of 1.56; no participation in off-farm job; dependency attitude on food aid and insecure land tenure perception. The probability for the base group was calculated by setting the dummy variables at 1.

Table 9. Simulated impact of determinants on the probability of household food security

Variables	Predicted Probability
Base	0.03
Participation in off-farm jobs	0.64
A shift to small family size (smaller than the sample mean family size)	0.40
A shift to high yield (larger than the sample mean yield)	0.26
A shift to large farm land size (larger than the sample land size)	0.22
A shift from dependency attitude on food aid to self-reliance	0.19
A shift to good wealth status (larger than sample mean TLU)	0.29
Improvement in household’s land tenure security	0.26

The conditional probability of food security for the base group of households is 0.03, indicating that of 100 households 3 are food secure. Holding other variables constant, if the base group of households with the above mentioned characteristics participates on off-farm jobs, the probability of food security increases from 0.03 to 0.64, which is the largest simulated impact. The probability of food security increases from 0.03 to 40% with a shift to small family size (smaller than the sample mean family size). A shift to high yield (larger than the sample mean yield) will increase the probability of food security from 0.03 to 0.26. A shift to large farm land size (larger than the sample land size) will increase the probability of food security from 0.03 to 0.22. A shift from dependency attitude on food aid to self-reliance will increase the probability of food security from 0.03 to 0.19. A shift to good wealth status (larger than sample mean TLU) and improvement in household's tenure security increase the probability of food security from 0.03 to 0.29 and 0.26, respectively.

Cronbach alpha value of 0.628 implies that the data used in the study has a good internal reliability.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

The main objective of the study was to identify some of the factors that influence household food insecurity in Tehuludere Woreda, South Wello Zone. The study used primary and secondary sources of data. In gathering the primary data, a stratified random sampling method was employed to select the final sampling units. Except post-harvest information, all predictor variables were obtained from the primary data. The period of the study was from November 2005 to November 2006. In order to determine the outcome variable (household food security status) a HFBM was adopted and the recommended daily calorie requirement was used as a national food security line. Household food insecurity causation was then examined using logistic regression model. At first, the study employed eleven predictor variables that were categorized under socio-demographic characteristics, resource endowments and agricultural technology use and attitudinal variables. In addition some interaction terms that were expected to have socio-economic and/or demographic importance were included in the model.

The descriptive analysis of the study reveled that only 30.8% of the sample households were food secure. The food insecure households (69.2%) felt short of the recommended calorie requirement by 37% while food secure households exceeded the recommended calorie requirement by 44%.

The results of univariate analysis indicated that except EDUC variable, each of ten predictors (OFFARAM, SEX, FSIZE, YIELD, LSIZE, TEC, AID, TLU, TENURE AND AGE) had the expected sign and were significant to be considered as candidates of the multivariate logistic regression model. By employing the forward step wise (likelihood ratio) method, seven out of ten predictor variables were selected as major determinants of household food insecurity. The goodness of fit assessment and significance test of each predictors of the multivariate logistic regression model were statistically significant results. This implies that the predictor variables have significant joint and separate influence in explaining the variation in the outcome variable. Model adequacy diagnostic tests of the multivariate logistic regression model shows that there were no outliers and influential values that had significant impact on the regression results. Besides, the colinearity diagnostic tests show that multicollinearity was not a great threat to the reliability of model coefficients.

The study revealed that non-participation in off-farm activities, having large family size (larger than the sample mean), low annual production or yield (less than the sample mean annual yield), small farm size (smaller than the sample mean farm size), dependency attitude on food aid, poor wealth status (less than the sample mean TLU) and insecure land tenure perception as positive and significant factors that contributed to high food insecurity. Analysis of the marginal effects of significant discrete predictor variables showed that, holding other variables constant, a shift to participation on off-farm activities decreases the probability of household food insecurity by 66%. Holding other variables constant, a shift to smaller family size (smaller than the sample mean family size) decreases the probability of food insecurity by 63%. A shift to high yield (larger than the sample mean) and large farm size (larger than the mean farm land size) decrease the probability of household food insecurity by 39% and 42%, respectively. Holding other variables constant, a shift from dependency altitude to self-reliance decreases the probability of food insecurity by 25%. A shift to good wealth status (larger than the sample mean TLU) and an improvement in land tenure security decrease the probability of household food insecurity by 38% and 31%, respectively.

Simulations were conducted using food insecure households as a reference group. The result indicated that participation in off-farm job, a shift to smaller family size (smaller than the sample mean family size), a shift to high yield (larger than the sample annual mean yield), a shift to larger land size (larger than the sample mean farm size), a shift from household's dependency attitude on food aid to self-reliance; a shift to good wealth status (larger than the sample mean TLU) and improvement in land tenure security have the potential to increase the number of food secure households in Tehuludere Woreda. Among all these, a shift to off-farm job significantly increased the proportion of food secure households from 0.03 to 0.64.

In general, in our opinion the food security indices estimated in this study were fair representations of the extent and dimension of food security/insecurity in Tehuludere *Woreda*. In order to achieve food security, strategies should be designed in a way that would focus on and address the identified determinants as well as other factors that are useful to achieve household food security.

CHAPTER SIX: POLICY IMPLICATIONS

The study identified seven important factors that influenced household food insecurity in Tehuludere *Woreda*. The policy implications of the study are summarized here under.

- Promotion of off-farm employment generating schemes could enable the farm household get diversified income sources. Support to diversification away from precarious livelihood systems (e.g. agriculture) towards sustainable alternatives whose returns are not correlated with rainfall such as agro-industry or services such as community-based tourism.
- Food and nutrition security interventions should integrate family planning, education and awareness raising programs in order to reduce the increasing population pressure on the available scarce resource.
- Increasing the productivity of major cereal crops through the use of increased farm inputs such as fertilizers, improved seeds, pesticides, credit service, access to irrigation facilities and post-harvest management would help to address food insecurity;
- The diminishing farm size has not only affected the profitability and level of technology use, but also the sustainability of rural livelihoods. Due to land shortage and increased population pressure, horizontal expansion in the study area may not be feasible. Hence, the thrust of household food security improvement rests on improving the quality of the land through improved soil and nutrient management, promotion of labor-intensive technologies, and creation of labor-intensive rural employment opportunities in the short-to-intermediate terms.
- The study indicated that food aid availability over a long period had a negative effect on the attitude of farmers towards work and their own agricultural activities. The implication is that proper targeting and awareness raising efforts should aim at reducing the attitude of dependency on food aid.
- Livestock was found as an important source of wealth that could contribute to food security in the study area. Hence, the output of the livestock sector should be strengthened through the provision or supply of better veterinary services.

- The study showed that land tenure insecurity contributed to household food insecurity. This implied that the issuance of land use certificate alone did not enhance farmers' confidence on land investment. This is because tenure insecurity could not only be triggered by fear of future land redistribution but also by the weak land administration that may lead to arbitrary violations of farmers' land use rights by local authorities or institutions, in which farmers' usually have low confidence. Hence, strengthening farmers' cooperative unions, implementing good governance and capacity building program interventions may help to have strong land administration that will eventually lead to building farmers' confidence.

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Annex I. Questionnaire

Determinants for Food Insecurity of Rural Households in Tehuludere *Woreda*, South Wollo Zone of the Amhara Region

1. Name of household head____
2. Sex of household head: 1=male 2=female
3. Age of household head(in years)___________
4. What is your literacy status?__________
   1=can read and/or write
   2=can not read and write
   3=cannot write
   4=cannot read
   5=primary (grade 1-6)
   6=junior (grade 7-8)
   7=secondary and above
5. Marital status: 1=single 2=married 3= divorced 4=widowed
6. Total number of family size (number)_________________
7. Religion: 1=orthodox 2= Muslim 3=Protestant 4=other(specify)______
8. Do you have your own land for cropping and pasture? 1=yes 2=no
9. If yes to 8, how much is your total farm land size (using local measurement unit)? __________________________________
10. Slope of your land: 1=plain 2=hilly 3=steep
11. How do you perceive the quality or fertility of your land?
    1=fertile 2=medium fertile 3=less fertile 4=poverished 5=poor
12. Do you have land use/tenure/ownership certificate? 1=yes 2=no
13. If yes to 12, what is your attitude towards the land use right certificate?
    1=builds my confidence
    2=doesn't build my confidence
14. How much of the following cereals did you harvest during November 2005 to November 2006? (using local measurement unit)
    Barely___________ Millet_______________
    Wheat___________ Sorghum_____________
    Teff_____________ Others_______________
15. How was the availability of rain on your fields during November 2005 to November 2006?
    1=enough 2=too much 3=too little 4= other______________
16. What were the different sources of food for your family during the year November 2005 to November 2006?

Food items	Total amount using the local unit of measurement				
	Own production	Received from food for work	Purchased from the market	Received from hiring out of labor	Received from food aid or relief food
Maize					
Wheat					

Barely					
Teff					
Sorghum					
Others					

17. Household food consumption during November 2005 to November 2006.

Food items	Total amount of food consumed (using the local unit of measurement)					
	Used for seed	Given out for hiring in labor	Given out for sharing in oxen	Repayment of crop loan	Marketed	Shared with relative
Maize						
Wheat						
Barely						
Teff						
Sorghum						
Others						

18. What employment and income earning opportunities are available in your area? (you may choose more than one)

1=only own farming (self-employment)
2=own non-farm employment (trading crafts)
3=farm laborer (work on other farms)
4=migration to work in other areas
5=non-farm laborer (work in cities)
6=other (specify)____

19. During last year (November 2005 to November 2006), how much estimated cash income did you earn per month from the following activities and sources?

Source of cash or activity	Earning per month (Birr)	Total earning per year (Birr)
From sales of own produced crops		
From sale of coffee, chat, enset,etc		
From livestock products(milk, eggs, butter, chickens)		
From sale of food aid received from FFW activities		
From sale of food aid		
From sale of firewood, charcoal, cow dung cake		
From non-farming activities(pottery, weaving, etc)		
From off-farm jobs (daily, labor, farm labor)		

Women household activities (tella, areke, tej, kolo, bread selling)		
Remittances from family members and relatives who live in elsewhere		

20. During November 2005 to November 2006, did you participate in any off-farm income generating activities?

    1=yes 2=no

21. Do you have/own livestock? 1=yes 2=no

22. If yes to 21, how many of the following livestock do you have?

Types of livestock	Currently owned on farm (number)
Oxen	
Cows	
Bulls	
Heifer	
Calves	
Sheep	
Goats	
Horses	
Donkeys	
Mules	
Camels	
Chickens	
Other	

23. During November 2005 to November 2006, on average, how much did you spend per month for the purchase of food and non-food items?

S.N.	Expenditure Item	Estimated expenditure per month (Birr)	Estimated total expenditure per year (Birr)
1	Food & stimulant items • Purchase of cereals, pulses, oil, fruits, vegetables, coffee, tea, chat, sugar, salt		
2	Non-food items • Purchase of farm inputs (fertilizer, seed, pesticide, veterinary drugs)		
	• Clothing, foot wear, gas, candle, firewood, charcoal, medical		

	expenditure, education and school fees for children		
	• Purchase of farm tools and implements		

24. Have you used any of the following agricultural technologies during November 2005 to November 2006 production season?

Type of agricultural farm inputs	Answer	
	Yes	No
Chemical fertilizer		
Pesticides		
Improved seeds		
Farm credit		
Access to irrigation water		
Others		

25. What is your attitude towards food aid?
1=food aid is good 2=food is not good
26. Is there any farmers' cooperative in your area? 1=yes 2=no
27. Are you a member of farmers' cooperative? 1=yes 2=no
28. If yes to 27, are you benefiting from the services of farmers' cooperative?
1=yes 2=no

Thank you !