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Food Security and Vulnerability Analysis At Household Level. Case Study, Rural Areas of Tigray Region, Ethiopia

By

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Under the guidance of

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Declaration

I, Eyob Bekele Juhar, declare that this thesis entitled as "**Food Security and Vulnerability Analysis at Household Level. Case Study Rural areas of Tigray Region Ethiopia**" is my own work and that all sources of materials used for this thesis have been duly acknowledged and I have undertaken the research work independently with the guidance and support of my research advisor. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree.

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Certification

This is to certify that this thesis entitled as "**Food Security and Vulnerability Analysis at Household Level. Case Study Rural areas of Tigray Region Ethiopia**" submitted in partial fulfillment of the requirements for the award of the degree of MSc. in Economics (Development Policy Analysis) to the College of Business and Economics, Mekelle University, through the Department of Economics, done by Mr. Eyob Bekele Juhar Id.No. CBE/PR177/03 is genuine work carried out by him under my guidance. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

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Abstract

Food insecurity in Ethiopia is a serious problem facing humanity. Households face recurrent food shortages most of which threaten their livelihoods and impact negatively on their Welfare. Empirical findings have shown that access to sufficient food is unstable. Suggesting that whether a household or individual is food secure at any point in time is best thought of in a dynamic sense. In this paper an analysis of vulnerability is conducted to find out which groups of households are more likely to be food insecure and to remain food insecure in the near future and to identify the influencing factors of vulnerability to food insecurity. Given the lack of panel data in the study area for an ideal vulnerability assessment, the methodology of Capaldo, Karfakis, Knowles and Smulders, (2010) developed for a cross sectional data is adopted. The study comprehensively looks the food security status at household level through different descriptive and econometric tools such as GLS,and logit model. Using a sample data of 2444 rural households from the 2011 Tigray Rural Base Line Socio Economic Survey (TRBSS) the study revealed that access to adequate food in the study area is unstable, only 48.07% of households enjoy stable levels of food security. In contrast, 28.77 percent of the sampled households were found in transitory situation moving in to and out of food insecurity and 23.16% of the population is undernourished (food insecure) while also being vulnerable; these are considered chronically food insecure. Implying that, food security interventions and policies based on static analysis miss significant proportion of the population in the study area. This work also identified who are vulnerable (some of the characteristics of households with higher vulnerability to food insecurity) and its influencing factors. Hence, it will help better planning interventions to improve the food security status in general and particularly of the study area.

Key words: vulnerability, food insecurity, rural Tigray.

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Acronyms and Abbreviations

AE	Adult Equivalent
CSA	Central Statistical Authority
DFID	The UK Department for International Development
ENHRI	Ethiopian Nutrition and Health Research Institute
FAO	Food and Agricultural Organization
FGT	Fosster, Greer and Thorbecke
GLS	Generalized Least Squares
GTP	Growth and Transformation Plan
IFPRI	International Food Policy Research Institute
MDG	Millennium Development Goal
MoFED	Ministry Of Finance and Economic Development
TLU	Tropical Livestock Unit
TRBSS	Tigray Rural Baseline Socio Economic Survey
UNICEF	The United Nations Children's Fund)
VA	Vulnerability Analysis
VEP	Vulnerability as Expected Poverty
VER	Vulnerability as Uninsured Exposure to Risk
VEU	Vulnerability as Low Expected Utility
VIF	Variance Inflation Factor
WHO	World Health Organization

Definition of terms (including local)

Tabia	Sub-district-The lowest administrative unit in Tigray
Tsimad	¼ of a hectare of cultivable land
Woreda	District level administrative unit contains many tabias

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Chapter One: Introduction

1.1 Background Of The Study

In spite of perpetual economic growth and development in many parts of the world, a substantial proportion of the global population continues to suffer from food insecurity and malnutrition. Millennium development goal one recognizes that hunger and food insecurity are the core hardships of poor people, and specifically sets out to halve the proportion of extremely poor and hungry people in the world. Even if the situation has improved since the 1990s, the rate of improvement remains far short of that required to attain these targets. The latest FAO figures suggest that 823 million people in developing countries are undernourished, which is an increase of 23 million since 1996. Nonetheless, over the decade, the proportion of undernourished people in the developing countries fell to 17 percent, because the total population grew faster than the undernourished portion. There is increasing evidence that the number of people who remain vulnerable to food insecurity is considerably higher (FAO, 2006).

According to international food policy research institute global food security is currently under stress. Although the world's leaders, through the first Millennium Development Goal, adopted a goal of halving the proportion of hungry people between 1990 and 2015, we are nowhere near meeting that target (IFPRI, 2010). The percentage of undernourished people fell from 20 percent in 1990–92 to 16 percent in 2004–06. In recent years, however, the number of hungry people has actually been increasing. In 2009, on the heels of a global food price crisis and in the midst of worldwide recession, the number of undernourished people surpassed 1 billion, although recent estimates by the Food and Agriculture Organization of the United Nations suggest that number will have dropped to 925 million in 2010. As matter fact, much of the world population is now suffering from famine and under nutrition. Such problem is aggravated from time to time in the least developed countries where their food intake is greater than food production (FAO, 2009).

The effect of under nutrition can be transferred from women to their children because malnourished mothers have a higher risk of giving birth to low-birth weight children, as do women whose own growth was stunted by malnutrition. Hence, maternal health and food insecurity are linked, and the damaging effects of hunger are passed from one generation to the next with malnourished mothers having low-weight babies who face a high risk of stunting during childhood. This can lead to a reduced work and earning capacity as an adult and puts them at a higher risk of giving birth to low-weight children themselves. Even children who are only moderately underweight have been found to be twice as likely to die of common infectious diseases as children who are better nourished(UNICEIF,2006). The United Nations Children's Fund (UNICEF) estimates that of the 146 million children under five who are underweight in the developing world, 106 million (73 percent) live in just 10 countries (UNICEF, 2006).

It is known fact that food insecurity causes poverty, vulnerability and livelihood insecurity, but is at the same time also a result of these situations. Eradicating extreme hunger speeds up progress towards the development goals in other sectors. Hunger and under nutrition make it extremely difficult for poor people to improve their own livelihoods and make it impossible for them to contribute toward sustainable and broad-based growth. The persistence of hunger is a direct confront to efforts to reduce child mortality, to improve educational attainment and to enable people to invest in their own futures (FAO, 2007).

In Ethiopia the combination of manmade and natural factors resulted in serious and growing food insecurity problem, which expose five to six million people to chronic and transitory food insecurity problem each year. In addition, ten million people are exposed to be vulnerable, with weak resilience (FAO, 2006). The extent of food security problem differs from region to region. Among food insecure regions of the country Tigray region is one seriously affected by food insecurity. As a result of the food deficient situation in the region, where even in a good year farm households can only meet 60% of their total food needs and the remaining is filled by food aid -both free and Food-For-Work (Sosina and H.Stein, 2007).

Food is the most basic of human needs for survival, health, and productivity. It is thus the foundation for human and economic development. As is now well known, enough food and much more is produced to meet the needs of all people in the world today. Hunger nevertheless remains a pervasive problem in developing countries, and much of the development agenda must focus

scarce resources on either providing food to people in need or enabling them to acquire it themselves. The foundation for doing so is a reliable information base on food insecurity that is, access by people to food which is the most immediate cause of hunger. Such information is fundamental to effectively targeting assistance, evaluating progress, and developing interventions. Its need is now more urgent than ever as efforts are stepped up to meet the Millennium Development Goal (MDG) of halving the proportion of people who suffer from hunger by 2015.

According to IFPRI (2006) reducing food insecurity in the developing world continues to be a major public policy challenge, and one that is complicated by lack of information on the location, severity, and causes of food insecurity. Such information is needed to properly target assistance, evaluate whether progress is achieved, and develop appropriate interventions to help those in need.

In Sub-Saharan Africa on the whole and in Ethiopia especially, households' capacity to manage risks is especially low due to multiple stressors coupled with a poor asset base, making them particularly vulnerable to food insecurity. Vulnerability to food insecurity is defined as the risk that a household will, if currently food secure, fall below the food security threshold, or, if food insecure remain in food insecurity. Vulnerability, therefore, is a forward-looking concept and is not directly observable. The observed food insecurity status of a household can be seen as the ex-post realization of potential food security states whose probabilities are predicted ex-ante as the household's level of vulnerability. A large proportion of observed food insecurity may be transient, with movements into and out of it. In particular, the welfare status of a substantial share of the population may be just above the food security threshold, with a high probability of falling below it in the near future. Consequently, policy interventions designed to reduce vulnerability are becoming increasingly important, making it crucial to develop reliable and easily applied measures of vulnerability to enhance the targeting efficiency of such policy measures.

As pointed out by Capaldo et al. (2010) food security policies should be based as much on the assessment of households' current conditions as on the expectation of their future access to food. So as to reduce the hazard of future under nutrition, policy design should address the uncertainty that households face alongside their risk-management options. Quite the reverse to this common sense, however, widely used food security analyses mainly consider present access to food.

Vulnerability analysis offers a solution to this problem by providing a quantitative estimate of the probability that a given household will lose access to sufficient food in the near future and hence, enable us to identify (i) who the vulnerable are, and (ii) the sources of vulnerability.

1.2 Statement Of The Problem

It is well thought-out that over 854 million people in the world are affected by food insecurity from which -According to assessments made by the Food and Agriculture Organization of the United Nations (FAO) in the years 2001/2003- 820 million are in developing countries, 25 million in countries in transition and 9 million in industrialized countries (FAO, 2006). A common strategy among different nations of the world to reduce or eliminate all manifestations of hunger and tackle food insecurity is currently under implementation as the World Food Summit and the Millennium Development Goals have proposed, i.e., to achieve the halving in the proportion of people in the world who suffer from hunger. The time horizon raised for the achievement of this goal is the year 2015, focusing on developing countries to generate food plans, national and regional programs, and public policies aimed at improving the food security.

With a population projected to reach 80 million in 2010 and about 45 percent living below the poverty line and most vulnerable to food insecurity, ensuring food security remained a key issue for the Government of Ethiopia (MoFED, 2002). In order to combat threats of famine and pervasive poverty and thereby ensure food security for its population, the government strategy has rested on increasing the availability of food grains through significant investments in agricultural technologies (high yielding varieties of seeds, fertilizer), services (extension, credit, inputs), and rural infrastructure (roads, markets). The impacts of these policies, however, have been shadowed as there are still millions of people who experience extreme hunger in the country (Bogale & Shimalis, 2009). Moreover, the achievement of food self-sufficiency is one of the key objectives of the government as articulated in its GTP and rural development policies and strategies, which is also consistent with the MDG goal of eradicating extreme poverty or hunger (MoFED, 2012). Mainly this is due to access to sufficient food and nutrients are essential for household welfare, as well as for accomplishing other development objectives. Households with insufficient access to food often face other challenges related to food insecurity including poor health and a decline in productivity. These challenges can often create a vicious circle whereby

households are unable to produce enough food, even in good years, because they are battling chronic health issues and are unable to work to their full potential.

The gravity of food insecurity, and its many rippling effects, has led much of the development agenda to search for specific areas for intervention given limited resources and growing populations in many developing countries. Moreover, it is essential for every country continuously to monitor its food security status, in order to uncover any hidden hunger, particularly creeping food insecurity, which may not be readily noticeable. In recent years there has been increasing awareness that the analysis of food insecurity should be carried out in a dynamic context. It is essential not just to look at the current incidence of an inadequate nutritional outcome, but also to identify the individuals, households or the communities who are more at risk of suffering in the future. The main analytical concept that has been developed in order to address the issue of the future incidence of food insecurity is vulnerability analysis. The concept of vulnerability had first been applied to the context of poverty (see Holzmann&Jørgensen, 2000, for an early application to social risk management), but it is increasingly acknowledged as an important approach for the analysis of food insecurity as well (Løvendal, Knowles and Horii, 2005).

There also has been a recognition of the need to develop analyses to inform policies that are not only aimed at the currently food insecure but at those who are likely to become food insecure in the future. The emphasis on forward-looking analyses has received a great deal of attention, but most studies on vulnerability look at poverty rather than at food security. While the two concepts are related, there are a number of specific issues with food security that should be explicitly addressed. To a large extent these depend on identifying the factors that result in food insecurity in the first place, which may not always be consistent with the factors that result in poverty (Scaramozzino, 2006).

A number of recent studies have provided estimates of food insecurity in Ethiopia on the basis of cross-sectional household surveys Policy makers have therefore acquired a good sense of the magnitudes concerning food insecurity and of its distribution across subgroups of the population. The current food security levels on an aggregate basis do not necessarily provide a good indicator of gauging future food security. The shift in the analysis from food security measurement based on realized outcomes towards vulnerability measurement based on expected outcomes helps

designing preventive food security policies. More importantly Policies and food security interventions based on static food security analyses do not capture the imminent needs of a potentially large share of the population that is likely to change its food security status in the near future. These include currently food secure households that may become food insecure in the near future and, on the other hand, households that are likely to overcome a currently food insecure situation without external assistance. Forward-looking analysis of vulnerability to food insecurity allows correcting these potential errors in policy design (Capaldo et al. 2010).

Cognizant of this fact, this study, attempted to fill the gap by undertaking Vulnerability analysis (VA). Vulnerability analysis facilitates targeting of programs by providing a quantitative estimate of the probability that a given household will lose access to sufficient food in the near future. A long way from being an intangible and slight distinction, this shift has major practical Implications; being able to identify (i) who the vulnerable are, and (ii) the sources of vulnerability greatly facilitates the design of preventive food security policies.

Research Objective

The main objective of the study is to analyze the current food security status and assess vulnerability to food insecurity in the future among households in rural areas of Tigray region.

Some of the specific objectives are:

i) To profile the level of household food insecurity in the study areas.

ii) To estimate the vulnerability to food insecurity of households quantitatively.

iii) To identify who is vulnerable to food insecurity and analyze the socio-economic characteristics of households with higher vulnerability.

iv) To scrutinize influencing factors of vulnerability to food insecurity.

1.3 Research Questions

In line with the above stated objectives, principal motivation of the present analysis is thus to explore the following questions.

1. What is the current rate of food insecurity in the research area?
2. Who is vulnerable to food insecurity and what are the characteristics of households with vulnerability?
3. Do the characteristics featuring households with food insecurity and households with vulnerability differ?
4. What is the degree of households' vulnerability to food insecurity in the rural part of the region and what are its influencing factors?

1.5 Significance of the Study

Food security and vulnerability analysis will enable us to identify the food secure and insecure households with in communities and try to predict how the different segments of population will be affected by un expected adverse events. Such an identification mechanism can be used to design appropriate pre and post shock institutional assistance strategies. Aid agencies and development organizations continue to face challenges of needs assessment and targeting interventions since there is a lack of mechanisms that can be used to differentiate food secure from food insecure or at-risk households. Therefore it becomes important to identify the food insecure sections of the society and predict how their situation be when they face an adverse shock. Once the insecure or at-risk households are identified and we know what resources they lack, interventions can be designed to provide the households with those resources, thus enabling them to get out of hunger trap.

Moreover, a deeper understanding of the characteristics of vulnerable groups would provide an empirical basis for social policy, thereby strengthening both the analytical and operational content of Ethiopian poverty reduction program in general and the study area in particular. This study therefore provide an approach on what can be done to help the current food insecure to be food secure and to reduce the likelihood of the vulnerable from falling into food insecurity in the future. Consequently, such studies are away from doubt important for the success of efforts to be

made in the area to ensure food security. Policy makers and planners will also draw lessons on designing effective strategies to reduce not only current food inadequacy faced by households but also exposure to future food insecurity.

1.6 Scope and Limitations of the Study

We assume that all members in a household with a per adult equivalent calorie consumption less than the calorie intake cut-off are undernourished. Conversely, all household members within a household with per adult equivalent calorie consumption above the cutoff are considered to be consuming sufficient calories. Various studies of Ethiopian household livelihood and coping strategies have found that household members may not fully share risk factors for undernutrition, and an individual in a household that is defined as not being undernourished, may be in fact undernourished (Dercon and Krishnan 2000). Given data constraints, we are unable to calculate calorie intake variations within the household.

Besides, the ideal vulnerability analysis requires panel data. However, in this study vulnerability estimation is made using the model developed to estimate vulnerability to food insecurity using cross-sectional data. This may cast doubt on the entire dynamism of the analysis.

1.7 Organization of the Thesis

This thesis manuscript is comprised of five main chapters. The first chapter presents introduction of the study that incorporates background of the study statement of the problem, objectives and research questions, significance, scope and limitations of the study. Chapter two, review of literature, illustrates the concepts as well as the theoretical and empirical basis of the study. Chapter three presents the setting, materials and methods used in the study. Chapter four presents the results and discussion in detail. Conclusions and recommendations based on the findings of the research work are presented in chapter five. Finally Appendix Tables that present some of the outputs of the regression analysis and conversion factors used in the analysis of the data.

Chapter Two: Review of Related Literature

This chapter is structured in the following way: section 2.1 clarifies definition and conceptual issues, presents justification to food security and vulnerability analysis and describes measurements of food security. Section 2.2 concepts of vulnerability and its measurement issues Section 2.3 approaches to vulnerability analysis and the last section, section 2.4 is devoted to review of empirical literatures related to food security and vulnerability analysis.

2.1 Definition and Concepts of Food Security

2.1.1. Food security

The dynamic nature of food security makes it to have different definition that evolved over time (Hoddinnott, 1999; FAO, 2003). The comparison of these definitions shows the considerable rethinking and reconstruction of officials thinking on food security over the past three decades (FAO, 2003). Food security as a concept emerged in the mid 1970s, in the discussions of global food crisis (Maxwell and Wiebe, 1999). The initial focus of food security was the one given by UN in 1974, which focused on food supply and price stability of basic consumable foodstuffs. This definition stated food security as "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN, 1975, as cited by Clay, 2002). This definition only indicates availability of sufficient food at a global level, yet it does not guarantee that everyone has access to enough food at an individual or household level. Moreover, it proposes a stable price as a means to ensure entitlement of food.

As a result, in 1983, FAO took up the center stage into further re-shaping the definition of food security to accommodate a new insight into securing access to vulnerable people to available supply of food. In other words, it was defined to maintain the balance between demand and supply sides of food security equation. It is stated as: "ensuring that all people at all times have both physical and economic access to the basic food that they need." (FAO, 1983). However, this definition does not tell us whether what individuals consumed is enough or not. Apart from this, it fails to show to what extent the consumed food has nutritional value for active work.

Understanding the abovementioned gap, in 1986 the most influential definition of food security concept was introduced by World Bank. This definition happens to include broader sense of food security and the clear difference between chronic food insecurity and transitory food insecurity, which are resulted by the natural calamity, economic crisis and conflict (Maxwell and Wiebe, 1999). This definition entitles mankind to have unlimited "access of all people at all times to enough food for an active, healthy life." (World Bank, 1986:1) and takes the availability of food and the ability to acquire as its integral essential elements.

Following a number of worldwide summits from the time when the World Food Conference in 1974 and based on work over several decades, the definition of food security is today in general agreed upon. The WFS in 1996 captured earlier work by adopting that *food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life* (FAO, 1996). This definition incorporates access to food, stability, availability of nutritionally adequate food and the biological use of food. *Food availability* refers to the physical presence of food at different levels from household to nationwide level, it may be from own production or through markets. *Food access* refers to the ability to obtain an appropriate and nutritious diet and is in particular linked to resources at the household level. *Biological utilization* relates to individual level food security and is the ability of the human body to effectively convert food into energy. The 'at all times' and *stability* dimensions point to the need for understanding current as well as likely future status at different points in time (Lovandal, 2005). Thus, analysis of food security must capture the temporal dynamics of food security.

From the definitions given to food security it is possible to see that there are four basic concepts, contained in the concept of "secure access to enough food at all times". These are: (a) access to enough food, defined by entitlement to produce, purchase or exchange food or receive it as a gift. (b) sufficiency of food, defined primarily as the calories required for an active, healthy life; (c) security, defined by the balance between vulnerability, risk and insurance and (d) time, where food insecurity can be chronic, transitory or cyclical.

According to FAO (2003), food security is a situation related to an individual, nutritional status of the individual household that needs to be pivotal for food security where the essential element in this case is the introduction of social dimension of food security. Thus, the working definition

of this study is the one given by FAO (2003:28), which is in line with the objectives of the study. Hence, food security exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life."

2.1.2 Fundamentals of Food Security

Households are food secure when they have year-round access to the amount and variety of safe foods that their member needs to lead active and healthy life. The food available to the household should be shared according to individual needs; the food must be sufficient in variety, quality and safety and each family member must have good health status in order to be benefited from the food consumed.

Food security is a broad concept, encompassing issues related to the nature, quality, and security of food supply as well as issues of food access. According to WHO (2010) each definition of food security involves the following three key elements. These are:

1) **Improving availability**: availability is a term used to indicate supply of food in terms of quantity and quality to provide adequate energy protein, carbohydrate and micronutrients to the population of a country on a sustainable basis. Availability to household is basically the capacity to acquire the food it needs which primarily could be satisfied by producing it. Any activity of a household that contributes to improve agricultural production or food supply would be considered as part of food availability strategy.
2) **Increasing access**; it is the strategy households apply to get the food. Households and individuals may acquire food through own production, purchase or national safety net mechanisms. The concept of vulnerability is highly related with the idea of access. Access is also the ability of a household to purchase food i.e. the physical availability of food commodities on the local market and ability of the household to purchase food.
3) **Appropriate use of available food:** food insecure households tend to have larger and high number of dependents. Meeting household food needs is the result of appropriate food use.

2.1.3 The Importance of Measuring Household Food Insecurity

For one thing, food insecurity is not a problem endemic to any one particular geographic region of the world. Studies aimed at designing more realistic and useful food insecurity measures have stated clearly that food insecurity is a problem in every corner of the world and is a "daily reality" (Webb et al. 2006, 1405) for millions around the world. Its assessment requires measures that can bring forth the causes and symptoms of food depravation or risk of depravation that are specific to the circumstances of the area and its population. Measuring any concept or phenomenon not only aids the process of inquiry but also promotes clarity and precision through standardization (Ibid). Since food security is a multi-dimensional problem there is a need to capture this concept in the form of an accurate measure to ensure that its critical components are not overlooked (Qureshi, 2007).

On the other hand, hunger and malnutrition are the direct consequences of food insecurity and they have important implications for the well-being of individuals, households and societies. According to the millennium project hunger task force report the labor productivity losses associated with malnutrition and hunger are on average between 6 and 10 percent of GDP and significant losses in children's cognitive abilities are also directly associated with malnutrition (Sanchez et al. 2005). The report in addition shows that food insecure and hungry people face political and social segregation. Another study shows that at the household level food insecurity leads to "physical impairment" through hunger and illness; "psychological suffering" through stress, fear and departure from norms; and "socio-familial perturbations" through distorted means of food acquisition and modification of eating patterns (Hamelin et al. 2002).

In view of the fact that many regions around the world face the problem of food insecurity and since its implication are so severe, obviously it is necessary to precisely quantify the current status, to have knowledge about the correlates of food insecurity and moreover to have deeper understanding of those who face higher probability of future deprivation in order to devise appropriate context-specific solutions.

2.1.4 Measures of Household Food Security

Measurement of household food security is usually indirect and based on food balance sheets and national income distribution and consumer expenditure data (Faridi, 2010). Linking hunger with inadequate food intake allows the measurement of food insecurity in terms of the availability and apparent consumption of staple foods or energy intake. This type of measurement corresponds to the earlier narrower definitions of chronic food insecurity. The above measure is calculated as the percentage of households in a population group who do not consume sufficient dietary energy. It is measured by determining whether a household acquires sufficient food over the reference period to meet the dietary energy requirements of all of its members. If the estimated total energy in the food that the household acquires daily is lower than the sum of its members' daily requirements, the household is classified as food energy deficient.

The requirements employed are those for basal metabolic function (a state of complete rest) and light activity, such as sitting and standing. There is some debate about what is the correct energy requirement. Energy requirement depends on age, sex, body weight, activity and lots of other factors. In practice, WHO (1985) recommendation is followed which is based on normatively specified minimum energy consumption levels given a minimum acceptable body weight for healthy people at each age and sex group. When the percentage of people, as opposed to households, is measured, each person is assigned the energy deficiency status of her or his household.

2.2 The Concept of Vulnerability and its Measurement

In the widely used literatures the idea of vulnerability is used with different implications. A basic difference exists between vulnerability as defenselessness in respect of a harmful event (for example, vulnerability to drought) and vulnerability to a particular negative outcome, following a harmful event (for example vulnerability to food insecurity). Much of the disaster management literature uses vulnerability with reference to a natural hazard (Alwang et al. 2001) while the food security literature, and part of the social risk management and poverty literature (Mansuri and Healy 2001; Dercon 2001a; Holzmann and Jørgensen 2000; World Bank 2000), defines vulnerability in terms of an unfavorable future outcome. This dichotomy is, to some extent, driven by the underlying policy questions that are sought to be addressed. Humanitarian aid and

disaster management tend to focus on short-term responses targeted at people who require relief assistance following a natural hazard, these being the vulnerable. Looking at vulnerability relative to a social welfare outcome, on the other hand, is concerned with guaranteeing a minimum welfare threshold in terms of food security, through short as well as longer-term measures.

Vulnerability surrounding an individual's or a household's human condition concerns the potential now of a negative outcome in the future. The concept is forward looking and implicitly also accounts for uncertainty surrounding future events. Poverty, on the other hand, is usually treated in static, non-probabilistic terms (Ravallion, 1996). It generally concerns not *having* enough *now*, whereas vulnerability is about having a high *probability now* of suffering a future shortfall. In practice, the poor are often also vulnerable, but both groups are typically not identical (Baulch and Hoddinott, 2000).

The concept of vulnerability as risk of shortfall can be expressed as a probability statement regarding the failure to attain a certain threshold of well-being in the future. To construct such a vulnerability indicator, one must identify a focal variable (x) e.g. food consumption, income, etc.; estimate the ex ante probability distribution (ft(.)) of ex post outcomes with respect to this focal variable xt+1; define a threshold (z) with respect to this focal variable (i.e. a poverty line/food security threshold); and determine a probability related threshold (θ) (i.e. a vulnerability line) such that a person will be considered vulnerable if the probability that his/her focal variable falls below the threshold z, exceeds (θ).

For the task at hand vulnerability is defined relative to the negative outcome of food insecurity following Løvendal and Knowles (2005). Thus, vulnerability refers to people's propensity to fall, or stay, below this food security threshold within a certain timeframe. Since vulnerability is linked to the uncertainty of events, everyone is vulnerable to food insecurity, but some more so than others. Vulnerability can be thought of as a continuum. The higher the probability of becoming food insecure, the more vulnerable one is. While 'the vulnerable' in established practice are often implicitly understood to be those with a probability of becoming food insecure above a certain predetermined threshold, no standard exists that defines this threshold. For the purpose of this study it is assumed that a cut-off point exists and so the term vulnerable refers to people below such predetermined threshold.

According to Lovandal and Knowles (2005) expanding the analysis of food security to include risks and risk management, and focusing on vulnerability is important for several reasons. First, numerous studies on poverty dynamics suggest that people move in and out of poverty. Summing up 13 panel data studies (Baulch and Hoddinott, 2000) showed that the share of the population being poor at times is often much larger than the share being always poor, and in some cases several times larger. If vulnerability is understood as the probability of experiencing at least one period of poverty in a given period, while 3 per cent in Pakistan comparing 1986 and 1991 were always poor, 55.3 per cent were sometimes poor making 58.3 per cent vulnerable. Following the same definition of vulnerability, Pritchett *et al.* (2000) show that in Indonesia at the level of current poverty of 20 percent, another 10–30 per cent of the population face a high probability of falling below the poverty line. The implication of this is that basing interventions on a snapshot at a given time will most likely miss a large part of the picture.

What one could deduce from the above is that, analysis of only current state of food security will likely miss important parts of the food security picture, both in terms of who the future food insecure are (targeting), why they are so (causes) and what can be done about it (policy options). Analyzing vulnerability offers a dynamic, forward-looking way of understanding food security dynamics, calling for explicit attention to risks and the options for managing these so as to improve future food security. Managing risks goes beyond assisting those affected by a particular shock in addressing their immediate food needs. A range of options are available for addressing longer-term food security through sustainable agricultural and rural development, aiming at preventing or mitigating risk.

2.3 Approaches to Vulnerability Analysis

In theoretical terms, vulnerability may be conceived as the threat that welfare may be compromised at a future date. This threat may be derived from two factors: first, those with high levels of welfare variability, and second, those with systematically low levels of welfare. Nevertheless, whichever the source of vulnerability, the concept is clearly tied to welfare outcomes.

Applications of vulnerability methods are closely linked to the way welfare is measured, there are three relevant approaches. The first is to assess vulnerability as expected poverty (VEP). This strand of studies seeks to estimate the probability that welfare may fall below some norm or minimum expected standard of living in the future (Chaudhuri, Jalan & Suryahadi, 2002). The second is quantifying vulnerability as low expected utility (VEU). Researchers in this area argues that using the VEP methodology is inconsistent with the expected utility framework, and proposes a measure of vulnerability to address these concerns (Ligon & Schechter, 2003). Finally, the last approach is vulnerability as uninsured exposure to risk (VER). This setting, contrary to the previous ones, stems from an ex-post, backward looking perspective, which concentrates on observed past outcomes rather than on an aggregate measure of vulnerability (Tesliuc & Lindert, 2002; Cruces, 2005; Cruces & Wodon, 2007).

Generally there is no established consensus in the literature regarding the most appropriate approach to the analysis of vulnerability. Furthermore, most analyses of vulnerability focus on poverty, rather than on food insecurity. Traditional approaches tend to emphasize the role of assets in reducing vulnerability. Even more crucially, some of the most common methodologies that purport to analyze vulnerability are static in nature, and thereby fall short of an appropriate assessment of the dynamic nature of vulnerability (Scaramozzino, 2006).

Sen's (1988) influential entitlement approach links vulnerability to inadequate access to assets, including intangible ones, such as social capital. However, access to assets offers no guarantee that the assets will be used in an effective fashion to reduce vulnerability. The UK Department for International Development (DFID), for example, develops its vulnerability assessments in terms of the household assets and activities required to maintain or sustain livelihoods (Department for International Development, 2003). By contrast, the World Bank uses a risk-based approach for assessing household vulnerability (World Bank, 2005). The "Social Risk Management" framework of the Bank considers the sources of vulnerability and the ability of the community to manage the associated risk. The emphasis is largely on minimizing risk exposure, although a major weakness in the approach is the absence of the consideration of those risks that stem from insufficient ownership or access to asset.

Many development agencies, including FAO, analyze vulnerability based on the sustainable livelihood approaches (*e.g.*, Devereux, Baulch, Hussein, Shoham, Sida & Wilcock, 2003). The FAO identifies currently vulnerable groups in terms of geographic location, and seeks to determine the causes of their vulnerability.

Within the outcome approach the measures of vulnerability vary depending on the definition of expected poverty. Chaudhuri (2001), Chaudhuri, Jalan & Suryhadi (2002) and Christiaensen and Boisvert (2000) use the expected headcount measure of poverty; Ravallion (1988) uses expected squared poverty gap to measure vulnerability, while Kamanou and Morduch (2002) consider expected changes in poverty as opposed to expected poverty.

On the other hand, the utility-based measures of vulnerability contrast the expected utility derived from consumption against the utility derived from consumption of a particular bundle with certainty. The utility function can be decomposed into distinct components measuring poverty and risk. The risk measure has the advantage of capturing both aggregate and idiosyncratic risk. This approach can in principle identify whether vulnerability affects those with low asset levels, unfavorable settings or low returns to assets. Ligon and Schechter (2004) have attempted to evaluate different measures of vulnerability by using various definitions and estimators of vulnerability using datasets from Vietnam and Bulgaria. The main purpose of their study is to allow practitioners with any given dataset to identify a suitable approach to measuring vulnerability. The outcome approach to vulnerability can help providing a quantitative measure of the incidence of vulnerability, which is useful in placing households with respect to the reference threshold, as policy can be directed towards particular groups.

This study follows the first approach, defining vulnerability as the threat of future deprivation. While the VEU approach has some attractive features in terms of its interpretation, it requires imposing common utility and risk preferences (Just and Pope, 2003). Finally, the third approach requires longitudinal data on households and for the purpose of this study only cross sectional data is available.

2.4 Empirical Literature Review

Analytical works that scrutinize food security and vulnerability in Ethiopia are scarce. Even the available ones are mostly descriptive focusing on explaining the extent of food insecurity and the determinants of food insecurity. Among a number of studies that made use of various methodologies to identify determinants of food security in different parts of Ethiopia, some are as follows.

A study done in Dire Dawa using the binary logit model, family size, annual household income, amount of credit received, irrigation use, age and educational status of the household head, cultivated land size, total livestock and oxen owned, were important determinants that influences households food insecurity (Abebaw, 2003). Abebaw concluded that a farmer with more cultivated land size has less risk of food insecurity.

According to study conducted by and Webb et al. (1992); livestock ownership, farmland size, family labour, farm implements, employment opportunities, market access, level of technology application, level of education, health status, weather conditions, crop disease, rainfall, oxen ownership and family size were identified as major determinants of farm households' food security in Ethiopia.

Ramakrishna and Demeke (2002) modeled different development interventions and their effects on household food insecurity and found that an increase in education of one person within the household would decrease the probability of food insecurity by 31.5 percent in the household. These results are similar to Christiansen and Alderman (2004) which attribute parental education as a main determinant of child nutrition in Ethiopia. Livestock holdings (increased by one unit) also diminish food insecurity by 24.38 percent. Conversely, an increase in family size resulted in more vulnerability to food insecurity by 36.25 percent.

Recently searchlight is being turned on vulnerability as means of solving social protection and poverty alleviation problems in the developed and developing countries' welfare studies. At the same time, the literature search revealed that there is a dearth of empirical evidence as regards vulnerability studies in the Ethiopia and especially in Tigray region. However, there are studies in other parts of the world with regard to vulnerability. Some studies on vulnerability stress identifying household-specific vulnerability characteristics and analyzing the differences in

household vulnerability by observable characteristics and determinants of vulnerability to poverty. The methodologies and results of such studies are discussed subsequently.

Chaudhuri, Jalan and Suryahadi (2002) and Chaudhuri (2003) provide some of the initial contributions to the recent literature on vulnerability as expected poverty. The framework developed in those studies are based on defines vulnerability estimates as probabilities, which are computed as the expected value of a poverty score in the future, conditional on a series of covariates. This poverty score takes the form of the Foster, Greer and Thorbecke (1984) FGT measures, specifically the headcount index (*FGT (0)*) which represents a probability (Kurosaki, 2007). The authors state that panel data of sufficient length would provide a better source for vulnerability estimates – the availability of repeated observations adds a crucial dimension (variability) to measures of household welfare. Given the scarcity of longitudinal data in developing countries, they have developed a series of assumptions under which cross-sectional data could form the basis of vulnerability estimates.

Chaudhuri et al. (2002) applied their methodology to cross-sectional data from Indonesia. Their results show that the vulnerable population is generally larger than the fraction observed as poor at a given point in time, implying that true poverty cost of risk is higher than the observed outcome. The authors also found differences between the distribution of vulnerability and poverty across different population characteristics (e.g. regions, educational levels, etc.). Chaudhuri (2003) applied these methods to cross-section data from the Philippines and Indonesia, finding similar patterns.

Other applications of the cross-section methodology provide findings along similar lines. These include Albert, Elloso and Ramos (2007) for the Philippines, who found a substantial gap in the level of vulnerability of households in rural and urban areas. In general, previous evidence finds that vulnerability is widespread, with vulnerable households usually outnumbering those that become poor. Moreover, some studies find several household characteristics that are associated with vulnerability levels (for instance, gender of the household head, educational levels, employment status and area of residence).

Quisumbing (2007) examined the concept of coping mechanisms, vulnerability and poverty among rural households of Bangladesh. He assessed the responsiveness of private and public

coping mechanisms and also attempted to link household-level vulnerability to the probability of being poor. Results showed that there is weak evidence that private coping mechanisms respond more to idiosyncratic changes in income than public transfers do. Poverty is strongly associated with many of the characteristics of groups that are more vulnerable to idiosyncratic shocks, but household level vulnerability is not highly correlated with poverty status, thus establishing an imperfect overlap between the vulnerable and the poor.

The evidence that imperfect overlap has been established between the vulnerable and the poor gives additional support for decision to study vulnerability and food security status of rural households in Tigray region.

Skoufias (2002) studied two other issues of vulnerability in Russia. These are establishing the differences in household vulnerability by observable characteristics and identifying household specific vulnerability. Results revealed that there are statistically significant differences in household vulnerability by region. Specifically related to food consumption, households with younger children appear to be less vulnerable (probably as a consequence of the child allowance they receive), while female headed households were more vulnerable. Household-specific vulnerability factors in Russia were identified using regression estimates as well as the construction of household specific vulnerability measures reflecting the ability of households to insure their consumption from idiosyncratic income risk. Results revealed that irrespective of whether vulnerability is measured on the basis of insurance from idiosyncratic shocks to income or otherwise, the variables that are significantly correlated with the level of household vulnerability are mainly those identifying the region in which the household lives. Measures of vulnerability were negatively correlated with the total consumption per capita. Thus, other things being equal in a cross-section of households, wealthier (poorer) households are less (more) vulnerable, as one would expect in issues of vulnerability.

The results of this study therefore suggest that the targeting of social safety net programmes need not be based solely on current poverty status of the household. Rather, social programme targeting can be effectively complemented with indicators of the ability of the household to protect its consumption from shocks.

Christiansen and Biosvert (2000) in their empirical analysis on measuring the household food vulnerability have illustrated a methodology to measure empirically household food vulnerability. They defined Food vulnerability in terms of the probability now of being undernourished in the future. They based on empirical analysis of panel data from northern Mali, collected in 1997-98. Their empirical results clearly show that even though the groups of currently undernourished and food vulnerable households overlap, they are far from identical. The empirical result shows that current food security and vulnerability to food insecurity are separate dimensions of wellbeing and failure to account for food vulnerability might lead to substantial underestimation of people's nutritional wellbeing. Result of their study indicated that food vulnerability increase unambiguously with the number of children in the house hold. Female-headed households appear less vulnerable to drought shocks, partly due to community solidarity. Households with good harvests are also less vulnerable, though greater dependence on agriculture attenuates this effect. Official food aid and family food gifts are important insurance mechanisms. Simulations indicate that food vulnerability can be significantly reduced through off-farm employment generation in the area and greater access to irrigation infrastructure.

From the reviewed literatures one may well see that there is a need to move a bit further in food security analysis to add other dimension of welfare so as to identify and characterize the current food insecure as well as future food insecure. Hopefully this will add some insight that will help in designing ways to allocate scarce resource towards alleviating the problem of food deprivation and its associated evils.

Chapter Three: The Setting, Materials and Methods

This part deals with the brief description of the study area and discusses the sources of data used in the study as well as the analytical model employed and the estimation procedure followed during the analysis of the data.

3.1 Description of the Study Area

Tigray is one of the national regional states of Ethiopia which is located in the Northern part of the country between 12^0 15'N and 14^0 57'N latitude and 36^0 27'E and 39^0 59' E longitude. It is bordered by the Amhara region to the south and south-west, the Afar region to the east, Eritrea to the north and north-east and the Sudan to the west. The total land area of the region is about 54,572 sq. kms. consisting of high plateau and mountains. The high plateau and mountain ranges are dissected by numerous streams feeding to the major river of Tekeze.

The topography of the region consists of high plateau and mountains with much of the land lying between 1000 and 3000 meters altitude. The climate of the region is variable due to the great variation in altitude. Generally there are two types of rainfall patterns in the region- mono modal and bimodal patterns. The main agro climatic zones of the region are *Kolla ,Wainadega,* and *Dega*. The region has been suffering from recurring droughts which appear to come in progressively shorter cycles. The impact of these droughts, which may be exacerbated with the general change in the global climate and its variability, will have a strong impact on the future economic development and food security of the Regional State.

According to the population and housing census of 2007, Tigray has a population of 4.314 million, consisting of 49.2% male and 50.8% female population. 19.5% of the total population are estimated to be urban inhabitants while the remaining are rural inhabitants. The population of the region is growing at a rate of 2.5% annually and the average population density stands at 76.7 persons per sq. km., with the highest density occurring in the eastern zone (123 persons per sq. km) and the lowest, in the western zone (19.3 persons per sq. km). With more than half of the population falling in the age category of less than 19 years, a very significant proportion of the region's population is made up of young people.

The region is highly vulnerable to recurrent droughts and with reducing trend of natural resources. Currently, the regional government together with other development partners is working to reverse this situation. Multifaceted efforts are being undertaken to improve the living conditions of the people in the region and the nation as a whole with the assistance of donor agencies and international communities. Though the region has potential resources that can minimize the food insecurity situation and improve socioeconomic development of the region, among others there are still financial, skills and management gaps of implementing institutions, which are the major development challenges of the region (UNICEF, 2009).

Furthermore, Tigray Region is one of the food insecure regions of the country. Prior to 1995 E.C, the regional government had identified 16 woredas as food insecure. However, the number of food insecure woredas increased from 16 to 31 as reported by the food security office of the region. According to recent data obtained from the Bureau of Agriculture, out of the 34woredas of the region only three woredas (Kafta-Humera, Welkayte and Tsegede) are food secure. The remaining 31 woredas of the region are classified as food insecure. Integrated family based packages and afforestation are under way to change the situation (UNICEF, 2009).

Realizing the magnitude and severity of food security, the regional government developed a food security strategy in 1999 to address the food security problems of the draught prone areas. Later it was extended to all weredas of the region except the three weredas beyond Tekeze river. The program was developed within the framework of the federal government's food security strategy. The region has also been introduced an integrated water shed development approach for improving household food security. Water shed was chosen as the appropriate unit area for development instead of administrative boundary. The objective is to improve and develop the natural resource base of the degraded and ecologically fragile areas of the region. Improving the incomes, and returns from marginal lands, food availability as well as the living conditions of the rural people were among the major goals of the watershed development program.

In line with Sustainable Development and Poverty Reduction Program (SDPRP), the regional government of Tigray has prepared a three years strategic plan ranging from (2004-2006) with the objective of eradicating extreme hunger in the region. The household intervention program introduced since 2003/2004 as one of the major components of the rural development strategy in the region was also mentioned as the main component to alleviate poverty from rural areas so as

to improve the wellbeing of the population. In line with Plan of Accelerated and Sustainable Development to End Poverty (PASDEP), the regional government also developed a five year strategic plan (2007-2010) to continue on the achievements the three years strategic plan. It had the following objectives:

- To build an agricultural sector with enhanced technology and increased productivity and transform the region in to an industrial economy
- To create a region with sustainable and balanced development
- To create a region where per capita income will be at par with the level reached by middle income countries.

Now the region prepares a Growth and Transformation Plan (GTP) for the period (2011-2015). The formulation of the GTP was based on the achievements of the previous strategic plan. Its main objective is to transform the agrarian economy to the industrial economy by paving the way for industry to lead the economy. Achieving food security in the region through increasing agricultural productivity is also another objective mentioned by the GTP.

3.2 Data Source

Tigray Rural Baseline Socio Economic Survey *(TRBSS)*, which is a cross sectional data that was collected in March 2011 by Collage of Business and Economics at Mekelle University in collaboration with Bureau of Planning and Finance of the region, having an objective of gathering socio economic baseline information of people of the region at household level and to use it as a bench mark to evaluate the resultant impact of GTP (Growth and Transformation Plan 2011-2015) designed by region up on the living condition (livelihoods) of rural and urban dwellers in the year to come is utilized as a main source for this study. The survey covered all 34 woredas and 12 administrative towns of the region. 2500 sample households from rural areas and 1000 sample households from urban areas were selected for interview. Out of the selected samples, only 2,463 samples from rural household and 921 samples from urban households were possible to be interviewed by survey.

In-depth interviews and field observations were the techniques used in survey to collect data both in rural and urban areas. As long as this study is conducted using data from the rural areas, it is more important to look at the data collection procedure carried out in rural areas of the region. First the list of all tabias in all rural weredas was identified. Each tabias in the weredas were

stratified according their agro-ecological conditions (either as highland and midland, midland, and low land). Based on this classification two tabias were selected randomly from each stratum.

Number of households for each wereda was allocated proportionally according to the population of the wereda obtained from the national housing and population census conducted by the CSA in 2007. After allocating the number of sampled population for each wereda, number of households for each tabia is also allocated proportionally based on the number of population of the tabia. In each selected tabia, a list of all households with in the tabia is obtained from the tabia administration. The list of households was used as a sampling frame to select households for the survey and systematic sampling technique was employed to select households from each tabia. In general household demographic and educational level, land holdings, crop output, livestock, household food security and copping mechanism, consumption level and poverty, health and nutrition, water, sanitation and hygiene, housing condition and access to public utilities, access to market, social services and infrastructure are the information included in the data set.

All samples information collected from rural households except 19 observations (with missing relevant variables for the analysis) is used to assess the current food security status and to estimate vulnerability to food insecurity in the in the region.

3.3 Methodology

In the analysis of the data different models were used with the view of addressing the objectives set forth in the present study. To attain the first objective that is related to the current food security status of the households in the study area, the objective measure that was suggested by (IFPRI) was used. The first step taken was distinguishing the food secure and food insecure. In order to classify into two groups, demarcation points or line is required. The government of Ethiopia has set the minimum acceptable weighted average food requirement per adult equivalent (AE) per day at 2200 kcal (MoFED, 2002). The determination of the adult equivalent takes into account the age and sex of each household member (Gassmann et al., 2006). Hence, for this study 2200 kcal per adult equivalent (AE) per day is employed as a cut-off value between food-secure and food-insecure households. Thus, those households who have energy per AE below the minimum subsistence requirement (2200 kcal) are deemed to be food insecure, and those who managed to attain the 2200 kcal per AE per day are considered to be food secure households.

In order to address the second objective of this study, that is to estimate vulnerability to food insecurity; following (Capaldo et al. 2010) a three-step process is passed. In order to project future food consumption, first a model of food consumption measured in kilocalorie where by the latter is a function of a number of household characteristics is estimated. In the second step, a model of the residuals that explains their variability is estimated. This second step gives us estimates of the residual variance. Lastly, the estimate of variance of the residuals is used to calculate the probabilities that kilocalorie consumption, which is assumed normally distributed, may be lower than an acceptable threshold. Estimation procedures and variables used are detailed subsequently.

3.3.1 Estimation of the Food Consumption Model

Choice and Derivation of Variables Used In the Regression:

- **Dependent variable**

The dependent variable used in consumption model, which serves as a vehicle to vulnerability estimation, in this study is food consumption measured in kilocalories. Consumption based rather than income-based measure of household food security status is used in this study. This is because consumption better captures long-run welfare, and it better reflects household's ability to meet their basic needs. Consumption is preferable to measure household food security status than income because it is less vulnerable to seasonality and life-cycle, less vulnerable to measurement errors because respondents have less reasons to lie, it is closer to the utility that people effectively extract from income, and for the poor most of income is consumed (FAO, 2002). The level of house hold calorie consumption is measured using the consumption approach based on the TRBSS 2011 survey data collected by Collage of Business and Economics, Mekelle University, in collaboration with Bureau of Planning and Finance.

Following this approach, level of house hold calorie consumption was set on the basis of the caloric content of consumed food items. To do this, first the bundle of food items acquired by households (either from own production, purchase, gift) is listed and measured in terms of kilo gram of solid food using conversion factors for the liquid food items. Second, for each food item a caloric content value was assigned based on the 1998 food composition table by Ethiopian

Nutrition and Health Research Institute (ENHRI) which is given in appendix table 1. Total food consumption was based on a list of 26 regularly consumed local foods from the different food groups (cereals, pulses, vegetables, and meat, milk and milk products).Third, due to differences in household compositions in terms of age and sex; there is a need to adjust the household size to adult equivalent household size. Adult equivalent household size constructed during the survey is utilized for this study.

The estimate of calorie acquired by a given household is done using the formula below:

$$C_i = \sum A_{ij} B_j$$

Where, C_i = level of kilocalorie acquired by the i th household in the study area.

A_{ij} = The weight in kilo grams of the food commodity j by the ith household

Bj = the standardized food energy content of the jth food commodity.

Calorie acquired encompass the calorie amount of all food acquired (own produced, purchased and obtained as gift and other transfers).

Because most foods are perishable and consumed with high frequency and people try to smooth their consumption of food over time, possibly one would expect their acquisitions to match fairly well with consumption, even over a short time period. However, certain foods, such as some grains, are not perishable and can be stored. Thus, over any given time period there will be households that are drawing down stocks acquired before the period in order to meet current consumption needs, while others will be accumulating stocks for consumption after the period.

Therefore, the amounts of food acquired and consumed over the same time period will not always be equal. In fact, in the typical household consumption and expenditure survey there will be households with calorie acquisition estimates far below what is needed for human survival. There will also be estimates that are far above what a person could possibly eat in one day. Randomly selected households in a population group are equally likely to be drawing down on food stocks as they are to be accumulating them. Thus, as previous studies have confirmed, the difference at the household level represents “random error,” and mean household calorie consumption should theoretically be the same as household calorie availability. It is in view of this fact that that the study used calorie acquisition to measure food security status of the households in the study area.

Explanatory Variables

Review of literature and past research findings, were used to identify the potential correlates of household food consumption. Accordingly, monthly per adult equivalent food consumption is estimated as a function of several variables representing the households' demographic and social characteristics, asset holdings, access to infrastructure, occurrence of shocks and geographic location.

Households do have differences manifested in sets of characteristics including size, composition, age structure, sex, occupation, etc. that affect the pattern of demand for food consumption. For this reason different household characteristics were included in food consumption model as explanatory variables.

***Family size*:** refers to the total number of members of the household irrespective of whether related or not who normally live in the same housing unit and have common cooking arrangement. As family size increases, obviously the number of mouths to feed from the available food increases. Hence, it is hypothesized that family size and food consumption per adult equivalent are negatively related.

Age of the household head: Age of household head also matters for household food consumption. Rural households mostly devote their lifetime or base their livelihoods on agriculture. The older the household head, the more experience s/he has in farming and weather forecasting. Moreover, older persons may accumulate more wealth than younger ones. However, if they have insufficient labor in their households, older household heads in rural areas may be in a disadvantaged position economically in undertaking the heavy physical labor required in agriculture this may result in food deprivation. Therefore the effect of age on hose hold food consumption may be indeterminate a priori.

Gender of the household head (head sex): *This* is dummy variable in the food consumption model which takes a value 1 if the household head is male and 0, if the household head is female. In view of the fact that male-headed households are in a better position to pull more labor force than the female-headed ones, sex of the household head is an important correlate of food consumption in the study area. One would expect that male headed households would consume higher food.

Household head education level (educi): These are dummy variables to represent different categories of education level of the household head such as; illiterate, religious/traditional, primary and secondary&/above secondary. Education equips individuals with the necessary knowledge of how to make a living. Literate individuals are keen to get information and use it**.** Hence, it is supposed that households who have had at least primary education are the ones to be more likely to benefit from agricultural technologies and thus acquire more food.

Major occupation (farming): This is dummy variable in the food consumption model which takes a value 1 if main occupation of the household head is farming and 0, otherwise. Agriculture in Ethiopia is nature dependent and most of activates take place in the rainy season in view of this fact any unfavorable weather situation can lead to poor harvest which may translate in to scarcity of food in the next period. Therefore, occupational leaning in farming is expected to be negatively associated with food consumption.

Asset ownership: Assets ownership of such as land and number of livestock in TLU as well as value of house hold assets were also included in food consumption model. The higher level of asset owner ship is expected to be associated with higher level of food consumption.

Credit user: This is dummy variable taking a value 1if the house hold has used credit and 0, if not. Credit may serve as an important source of income to smooth consumption over time. Those households which received the credit they requested have better possibility to spend on activities they wish. Either they purchase agricultural input (improved seed and/or fertilizer) or they purchase livestock for resale after they fattened them. Therefore it is expected to be positively correlated with food consumption.

Access to remittance: access to a remittance is used as a measure of the ability of a household to receive assistance from members living outside the location and as a proxy of a diversified income portfolio

Proxies for shock variables: These are dummy variables included in food consumption model to represent the incidence of a covariate shock (such as drought) and an idiosyncratic shock (illness of the household head), which takes on the value1 if the house hold had faced the shocks and 0, otherwise.

Geographic location (zon_i): These are dummy variables that represent different locations of residence for the households, included in food consumption model to capture spatial variations on the level of food consumption. This later facilitates identification of the most food insecure households. Residence area may impact the level of food consumption as different areas present different employment or source of income opportunities.

Table 3.1 list of variables used in food consumption estimation

Calorie	per adult equivalent daily calorie intake in kilocalories
Households demographic and social characteristics	
Sexhead	sex of household head 1 if male, 0 female
Agehead	age of household head in years
Hhsize	number of household members;
$educ_i$	dummy variables for Head's education
	Illiterate, religious education, primary, secondary and above
Farming	dummy variable indicating main economic activity of the head 1if farming, 0 other wise
conexpenditue	Consumption expenditure of the house hold
Asset holding	
Landown	land owned by household in tsimad; (farm size)
Livestock	Live stock ownership in (TLU)
Valuehha	Value of household asset
Access to consumption smoothing options	
Credit	1if the household used credit, 0 otherwise
Remittance	1 if the house hold has access to remittance,0 otherwise
Shocks	
Drought	1 if the house hold faced Drought shock,0 otherwise
Illness	1 if the house hold faced Illness of the house hold head, 0 otherwise
zone i	Dummies for location of the household

3.3.2 Empirical strategy toward measuring vulnerability

An analysis of the current literature on vulnerability make it apparent that at present there is no consensus on the conceptual framework that is, on how to define and measure vulnerability and on which empirical methods are the most appropriate for the evaluation and assessment of policies targeted at reducing vulnerability. Existing models of vulnerability can be grouped into two large categories: (a) models that analyze vulnerability to stochastic events – usually shocks, hazards or risks – and (b) models that analyze vulnerability to the outcomes of those events. The former, typically concerned with short-term disaster management, are based on strong ad hoc assumptions. The latter focus on the longer term patterns of poverty and deprivation and can be further split into models that measure outcomes with statistical indicators (consumption, land ownership, human development index, etc.) and models that measure outcomes in terms of utility (see Ligon & Schecter, 2004, for a review).

As argued by capaldo et al., (2010) at whatever time policy formulation call for quantitative information, statistical outcome-based models are most appropriate for vulnerability analysis. Undeniably they have produced many interesting empirical results (Chaudhuri et al., 2002; Christiaensen & Boisvert, 2000; Christiaensen, & Subbarao, 2005). Although a mainstream model has not yet arisen in the research on vulnerability to food insecurity, a few interesting models exists (see Capaldo et al., 2010 for complete list). FAO has added to the diversity of approaches through the introduction of the analysis of resilience (Alinovi et al., 2008) to assess how households adjust their livelihoods after a series of shocks have occurred. This analysis assesses longer term patterns with non-parametric methods.

Conceptually, studies differ in their definitions of vulnerability, partly due to the limitation of data. For this study, following Chaudhuri et al., (2002), vulnerability to food insecurity is defined as the probability that a household will not have enough food in the future. Ideally, with a panel data of sufficient length the probability distribution of the household's food consumption can be directly estimated. However, panel data are typically not available, especially in developing countries like Ethiopia and particularly in the study region. In practice, cross-sectional data can be used to estimate the inter-temporal variance by allowing heteroskedasticity with the variance depending on some observable household characteristics, like mean of household consumption (Chaudhuri et al., 2002).

The main aim of a forward looking vulnerability to food insecurity estimation is to have an estimate of household's over time mean and variance of calorie consumption. If possible, this requires panel data collected over a sufficiently long period. However, in this study the model of vulnerability to food insecurity proposed by (Capaldo et al., 2010) particularly for cross-section data is used. This however requires relatively strong assumptions about the stochastic process generating consumption. The absence of recent panel data representative of the study area has largely driven this choice.

Following (Capaldo et al., 2010) a three-step process is passed. In order to project future food consumption, first a model of food consumption measured in kilocalorie where by the latter is a function of a number of household characteristics is estimated. Then in the second step, a model of the residuals that explains their variability is estimated. This second step gives us estimates of the residual variance. Lastly, the estimate of variance of the residuals is used to calculate the probabilities that kilocalorie consumption, which is assumed normally distributed, may be lower than an acceptable threshold.

Algebraic structure

For a generic household h let C_h indicate kilocalorie consumption and X_h be a vector of, observable household Characteristics such as household size, location, educational attainment of the household head, etc. that serve as explanatory variables of per capita kilocalorie consumption.

Assuming for simplicity a linear dependence, each household's calorie consumption can be expressed as follows:

$$C_h = X_h^{'}\beta = \beta_1 x_{h1} + ... + \beta_2 x_{h2} + ... + \beta_j x_{hj} \quad (1)$$

Where, β is a vector of parameters that are the same for all households.

Considering all households in one multivariate equation, we have:

$$C = X\beta = \begin{bmatrix} \beta_1 x_{11} + ... + \beta_2 x_{12} + ... + \beta_j x_{1j} \\ . \quad . \quad . \\ \beta_1 x_{h1} + ... + \beta_2 x_{h2} + ... + \beta_j x_{hj} \\ . \quad . \quad . \\ \beta_1 x_{H1} + ... + \beta_2 x_{H2} + ... + \beta_j x_{Hj} \end{bmatrix} \quad (2)$$

Where $C = [c_1 ... c_h .... c_H]$ and $X = [X_1^{'} .... X_h^{'} ..... X_H^{'}]$

The first step of three_step generalized least square (GLS) procedure consists of estimating the multivariate equation and obtaining estimates $\hat{\beta}$ of the parameters that explain calorie consumption.

But for the residual component,

$u = [u_1 ..... u_h ..... u_H]$

$$C = X\hat{\beta} + u \quad (3)$$

As a second step, assess their dependence on the same explanatory variables through a set of parameters γ. Estimate the equation:

$$u = X\hat{\gamma} + \varepsilon \quad (4)$$

Where **ε** is the vector of residuals of this second estimation, showing all the desirable properties of residuals that ***u*** does not have. From the deterministic part of equation (4) and after correcting again for heteroskedasticity, one can derive a consistant estimate of the house hold variance of food consumtion $\hat{\sigma}_u^2$.

In the last step of the procedure, $\hat{\sigma}_u^2$ is used to compute each household's vulnerability to food insecurity. Assuming that vulnerability distributes normally, each household's probability of food insecurity is given by a determination of:

$$v_h \sim N(E(u_h), \sigma_h^2) \quad (5)$$

In this context for a given household *h*, the vulnerability is defined as the probability that each household faces of falling below the minimum energy requirement in the future.

3.3.3 Vulnerability threshold

Any operationally useful assessment of households vulnerability status depend essentially on the choice of vulnerability threshold, that is, the minimum level of vulnerability above which all households are defined to be vulnerable. In the vulnerability estimation each estimate takes values in the interval [0 1]. The extremes of the interval represent two opposite certainties: when, $\mathbf{v_h=0}$ household will consume in the future with certainty *at least* the minimum amount of calories prescribed by the threshold; when, $\mathbf{v_h=1}$ household will consume *less* calories in the future than prescribed by the threshold. In all intermediate cases, when, $0<v_h<1$, no particular outcome is anticipated *ex ante*. By comparing the estimated probabilities with an arbitrarily-chosen threshold of vulnerability, households are classified as vulnerable if their estimated vulnerability level falls short of the threshold of vulnerability.

The choice of the cutoff depends on the purposes of the analysis. The median would be more appropriate when designing policies to redress inequality, whereas the 0.5 value is more appropriate when planning interventions to address absolute deprivation. In this study the 0.5 is used as a cutoff, considering 'highly vulnerable' those households whose probability of future under nutrition is higher than the probability of sufficient nutrition.

3.3.4 Generating Vulnerability to food insecurity Profile of Different Segments of Rural Households in the study area

This objective is achieved by defining a vulnerability to food insecurity line in terms of chosen cut off probability. In this study a threshold vulnerability level of 0.5 was chosen, since the equation for the estimated vulnerability follows a normal distribution. After the vulnerability indices were generated for each household, those with indices equal to or above 0.5 were termed highly vulnerable while those below 0.5 were termed low-vulnerable. This allows us to generate the proportion of the population that is highly vulnerable both in the total population of rural households at large and also within various segments of the rural households. The vulnerability profile was constructed in such a way that it highlighted the vulnerability to food insecurity profiles of respondents taken into consideration their various demographic characteristics. Vulnerability profiles of this type are useful illustrative devices in the discussions of policy priorities among the various respondents with peculiar demographic characteristics.

3.4 Determinants of vulnerability

Finally, in order to address the fourth objective of this study the binary logistic regression model is employed to examine an association of each factor with vulnerability to food insecurity. To analyze the factors that determine vulnerability to food insecurity households were classified in to two categories as low vulnerable and high vulnerable using the threshold chosen (0.5) Variable. Thus, the dependent variable in this case, vulnerability, is a dummy variable, which takes a value zero or one depending on whether or not a households vulnerability index is less than or greater than the chosen threshold.

In widely used economic literature for estimating binary choice models the linear probability, logit and probit are the possible alternative models and have been widely used for a binary response variables. A linear probability model is plagued by several problems such as non normality of the disturbance term (u_i), hetroscedaciticity of u_i, possibility of predicted y hat lying outside the range(0-1) and generally lower R^2 values (Gujirati, 2003). As a result hypothesis testing and constructing confidence interval become inaccurate and misleading. And moreover the predicted values (y hat) lie outside 0-1 range and violate the basic idea of probability. The shortcomings of linear probability model suggest that non linear specifications may be more appropriate.

For this reason, in the studies involving qualitative factors, usually a choice has to be made between logit and probit models. According to Amemiaya (1981), the statistical similarities between the two models make the choice between them difficult. However, Maddala (1989) and Kmenta (1986) reported that many authors tend to agree on the logistic model since the cumulative normal functions are very close to the mid range but the logistic function has slightly heavier tails than the cumulative normal functions. It is also argued that the logit and probit formulations are quite comparable, the main difference being that the former has slightly fatter tails; that is, the normal curve approaches the axes faster than the logistic curve. Moreover, a logistic distribution (logit) has advantages over the other in the analysis of dichotomous outcome variable in that it is an extremely flexible and easily usable model from mathematical point of view and results in a meaningful interpretation.

Thus in this study the logit model was selected to identify the determinants of vulnerability to food insecurity in the study area.

$$v_h = \delta x_h + £_h$$

=0 otherwise.

Where v_h is vulnerability to food insecurity, δ is a Kx1 vector of unknown parameters, x_h is 1xK vector of explanatory variables and $£_h$ are the models residuals.

To scrutinize the determinants of vulnerability to food insecurity the measure of vulnerability is regressed on the set of house hold characteristics.

Chapter Four: Results and Discussion

The data analysis is done using STATA. The results of the analysis are divided into four sections: descriptive analysis results, Results from food consumption estimation, Extent of Vulnerability to Food insecurity and correlates of vulnerability to food insecurity. These results and their discussions are presented below.

4.1 Descriptive Analysis

4.1 .1 General description of socio-demographic and economic characteristics of sample households

Understanding of general characteristics of sampled households is expected to provide bird's eye view of the general features prevailing in the study area. Particularly, it is important to determine the socio-demographic characteristics of the heads of households because they are the main contributors to the livelihood of their households. Therefore, an attempt has been made in the study to analyze some important characteristics of the sample households. Table 4.1 summarizes the socio-demographic and economic characteristics of the heads of households. The average age of household heads is about 47 years. Majority of them are in age range 41-60 (about 47% of the sampled households). This age structure may be an indication that they are also in their active reproductive stage thereby having implication for household size in the future. Household size averaged about five members with standard deviation of two. This seems not to be large as it is almost equal with the national average for rural households 4.9 (CSA, 2007) but there are households with as many as 12 members. Larger household size nonetheless may be a precursor to low per capita consumption ceteris paribus. The gender dimensions of the households show that they are mainly headed by male with only 24 percent out of 2444 sample households headed by female.

Table 4.1 descriptive statistics of variables used in the model

Variables	Mean	Std. Dev.	definition
ak_calpae	2809.06	1492.01	Acquired kilocalorie per adult equivalent
totcon_exp	13181.47	9779.75	Consumption expenditure
q1_1_4agea	47.28	14.13	Age of the household head (years)
agesqu	2435.58	1435.65	Age square
tot_family~1	5.34	2.22	Family size
land_paequ	.92	1.00	Land owned per adult equivalent
valueofhha~s	14807.49	31904.16	Value of household assets
educ1	.61	.49	Head illiterate
educ2	.07	.25	Head religious/traditional education
educ3	.28	.45	Head primary education
educ4	.03	.18	Head secondary&/above education
farming	.93	.25	Main activity farming
sexhead	.76	.43	Sex of the head male
illness	.03	.17	Illness shock for household head
q9_1_101dr~t	.58	.49	Drought shock
remittance	.13	.34	Accessed remittance
credit	.64	.48	Access to credit
zon1	.25	.43	Central zone
zon2	.19	.39	Eastern zone
zon3	.18	.39	North western zone
zon4	.14	.34	Southeastern zone
zon5	.08	.27	Western zone
zon6	.16	.37	Southern zone
Number of observation			
2444			

Source; own computation based on TRBSS (2011) data

Occupation wise most households' main activity is farming, that means they are in agriculture which in Ethiopia is mainly weather dependent. In this connection any unfavorable weather situation can lead to poor harvest which may translate into scarcity of food in the next period. Further, the weather dependency of agriculture means abundance of food at one time and scarcity at the other. Another result from Table 4.1 is the extremely low educational attainment of the heads of households. The adult illiteracy rate is about 61 percent. Of the 39 percent of households who have some education, about 7 and 29 percent have religious/traditional education and primary education, respectively. However, only about 3 percent of the household heads have secondary and/above secondary education.

4.1.2 Food Security Status and Demographic Characteristics of Households in the study Area (profile of food security status in the study area)

This section briefly reports the association between the food security status of the households in the study area and their related demographic characteristics. Among household characteristics sex of the household head, age, household size and education level of the household head are included.

Since food is the most basic of human needs for survival, health, and productivity and thus the foundation for human and economic development. The rate of food insecurity in any given area is often used as a measure of welfare of households in that area. In this study the categorization of households in to food secure and food insecure is based on an assessment of whether household current consumption is above or below the minimum recommended food energy consumption (measured in kilocalories).

As it has been clearly discussed in the methodology part acquired food items by the households which is converted to kilo calories using food to energy conversion factor table as shown in (appendix table1) is used as a measure of food security status and the households in the study area are classified in to food secure and food insecure based on the comparison of their calorie acquisition per adult equivalent and the minimum recommended level of food energy consumption (2200 kilocalories) in this case following MoFED (2002) .

Table 4.2 category of household into food secure and insecure

Household category	Number of households	Percent
Food secure	1,511	61.82
Food insecure	933	38.18
Total	2444	100

Source; own computation based on TRBSS (2011) data

It is well known that in Ethiopia the head of house hold strongly influences the household's livelihood and their demographic features would then influence, to some extent type and source of income hence acquisition of food available from different sources. For this reason an attempt has been made to assess the difference in food security status that exists between different house hold head characteristics. As shown in table 4.3 the mean family size for food insecure and food secure households are found to be (6.21) and (4.85) respectively. The food insecure households have larger family size. This finding concedes with study done by Bogale (2009).

The result of the survey also shows that both dependency ratio and age of house hold head were found to be relatively higher for food insecure households than food secure households. Mean acquired kilocalorie per day per adult equivalent for food insecure households is (1612.42) kilocalorie which is below the minimum required level (2200 kilocalorie). This shows on average the food insecure far below the minimum threshold by 587.58 kilocalories.

Table 4.3 Food security status of households by mean family size, dependency ratio, age of household head and acquired kilocalories per adult equivalent per day.

Food security status	statistics	Family size	Dependency ratio	Age of house hold head	Acquired kilocalories per adult equivalent per day
Food insecure	Number of observation	933	930	932	933
(<=2200 kc)	mean	6.21	1.06	48.52	1612.42
	Standard deviation	2.08	.79	12.69	445.71
Food secure (>2200 kc)	Number of observation	1511	1501	1510	1511
	Mean	4.85	1.01	46.52	3547.95
	Standard deviation	2.15	.79	14.89	1431.04
total	Number of observation	2444	2431	2442	2444
	Mean	5.37	1.03	47.29	2809.06
	Standard deviation	2.22	.79	14.13	1492.01

Source; own computation based on TRBSS (2011) data

The mean acquired kilocalorie per day per adult equivalent for food secure households is 3547.95 kilocalories. This seems far above the minimum required level 2200 kilocalories but with high standard deviation of about1431.04. Hence it is rational to expect that there might be possibility for the food secure to fall in to food insecurity or there will be high vulnerability to food

insecurity in view of the fact that the mass of the households occupation is farming where risk and uncertainty are common features.

Table 4.4 Food security status by sex and education level of households head

House hold heads sex&		**Total households**		**Food insecure**		**Food secure**	
Education level		**N**	**%***	**N**	**%****	**N**	**%*****
sex	male	1863	76.23	746	79.96	1,117	73.92
	female	581	23.77	187	20.04	394	26.08
	total	2444	100	933	100	1,511	100
Education level	illiterate	1492	61.05	588	63.2	904	59.83
	Religious/traditional	170	6.96	66	7.07	104	6.88
	primary	702	28.72	258	27.65	444	29.38
	Secondary&/above	80	3.27	21	2.25	59	3.90
	total	2444	100	933	100	1511	100

Source; own computation based on TRBSS (2011) data

* *out of total sample house holds*

***out of food insecure house holds*

****out of food secure households*

- ***Categorization of food security status by household head sex***

As table 4.4 shows the food insecure female headed households accounted for (32.19) percent of the total female headed households. On the other hand food insecure male headed house hold accounts for (40.04) percent of the total male headed households. This is somehow contrary to the common observations that female headed households, in developing countries like Ethiopia to be food insecure as compared to their male headed counterparts, For instance Antigen (2010) found that larger proportion of female headed households (72.2 percent as compared to 54.9 percent for male headed households) as food insecure. In the case of this particular survey; it seems that female headed households face lesser incidence of food insecurity. The possible reason for this could be larger family size in the male headed households which exert much on food consumption than its contribution to production. Indeed the difference vanishes when we control for other differences between male headed households and female headed households as one could see in the multivariate analysis in section 4.2.

- ***Categorizations of food security status by education level of the household head***

Provided that the data used in this study is collected from rural area where illiteracy is pervasive as it has been found by different researches, the result obtained shows the same fact. Accordingly, in the survey 61.05% of household heads were found to be illiterate. Even in the literate sub group majority of them attended education only up to primary. Consequently only insignificant number of household heads were found to have secondary and above education level. The maximum and minimum food insecurity incidence is 39.41% & 26.25% for households headed by illiterate and households headed by educated up to secondary and above respectively. This result is consistent with other studies conducted in different parts of Ethiopia (for example Hagos, 2010; Antigen, 2010).

4.2 Results from food consumption estimation

The results of the model of food consumption estimated using GLS to account for hetroscedaciticity are reported in Table 4.5. In general, the model performs well. The goodness of fit measure, R^2, is 0.47, sufficiently high for models using cross-sectional data. In addition, many coefficients of control variables have the expected sign and are statistically significant. After accounting for heteroskedasticity through the use of generalized least squares, vulnerability to food insecurity

estimated as the normal probability that the "individual minimum dietary energy requirement under light physical activity" exceeds the expected individual dietary energy consumption (measured in kilocalories). Since our interest is in estimating the relative vulnerability of households to food insecurity. The model of food consumption measured in kilocalories in this study serves as a vehicle to estimate relative vulnerability and not to identify direct causes of inadequate food consumption. Therefore interpretations of the coefficients are in accordance with this. The following section presents discussion on some of the correlations, which preliminarily trace causes of insufficient dietary energy consumption. Estimation results for the model of calorie consumption and the variance of consumption are given in table 4.5.

Table 4.5 GLS Regression: The expected value and variance of log per adult equivalent Food Consumption (measured in kilocalories)

	(1)	(2)
VARIABLES	Log of kilocalorie consumption per adult equivalent per day $E(\ln C / X)$	Variance of log kilo calorie consumption $Var(\ln C / X)$
Log of consumption expenditure	0.413***	-0.142*
	(0.0270)	(0.0810)
Age of the house hold head	-0.0136**	0.00179
	(0.00620)	(0.00740)
Age square	0.000119*	-1.13e-05
	(6.19e-05)	(7.32e-05)
Family size	-0.122***	0.0123
	(0.00961)	(0.00890)
Land per adult equivalent	0.0481***	0.00719
	(0.0169)	(0.0142)
Log of value of house hold asset	-0.000634	0.0476**
	(0.00686)	(0.0204)
Religious/traditional education	-0.247***	-0.0440
	(0.0902)	(0.0341)
Primary education	-0.0367	-0.0153
	(0.0324)	(0.0277)
Secondary and/above education	-0.00437	-0.0281
	(0.0645)	(0.0421)
Major occupation farming	-0.00494	-0.0461
	(0.0411)	(0.0856)

Sex head (male)	0.0237	-0.00938
	(0.0310)	(0.0484)
Illness shock	-0.0166	-0.0700*
	(0.0574)	(0.0389)
Drought shock	0.0746***	-0.0156
	(0.0248)	(0.0307)
Remittance	-0.0186	0.0140
	(0.0328)	(0.0440)
Ever used credit	-0.0185	-0.00187
	(0.0306)	(0.0316)
Central zon1	0.0786**	0.0673*
	(0.0324)	(0.0372)
Eastern zon2	0.164***	0.0851**
	(0.0394)	(0.0359)
North western zon3	-0.0359	0.114***
	(0.0410)	(0.0335)
South eastern zon4	-0.178**	0.119***
	(0.0727)	(0.0423)
Western zon5	0.0598	0.130**
	(0.0513)	(0.0646)
Constant	4.905***	0.931*
	(0.279)	(0.483)
Observations	2,366	2,442
R-squared	0.471	0.018

**** p<0.01, ** p<0.05, * p<0.10(* Significant at 10%; ** significant at 5%; *** significant at 1%)*

Note: the figures in parenthesis are Standard errors

Source; own computation based on TRBSS (2011) data

Column (1) of table 4.5 shows that consumption expenditure which is used as a proxy variable for income has a positive and significant correlation with the level of calorie consumption among the households. The result is also in agreement with those of other previous studies from Nigeria (Aromolaran, 2004; Agboola et al., 2004) who found income has a positive and significant relationship with calorie consumption.

The results further show that age of household head has a significantly negative correlation with calorie intake. This is probably because older people are often less aware of the need for adequate nutrition intake. Moreover, the capacity to access sufficient calories declines with age. However, this negative correlation weakens with age since the coefficient on age squared is positive and significant. The possible explanation for this could be support from the offspring's. As a process of life the formerly dependent family members become economically active and contribute to the family's food consumption level.

Large household size significantly reduces expectation of food consumption. It is well-known that families with many children are, on average poorer, *ceteris paribus*. No evidence is found on gender of the household head to be associated with expected food consumption. The household's food consumption expected to be better significantly due to change in the per adult equivalent farm size ownership. As one expects farm size (land ownership per adult equivalent) have the largest positive correlation with the level food consumption. The higher land ownership, the higher expected food consumption will be.

Households with heads religious/traditional education are more vulnerable and thus more likely to face reduced food consumption in the future. On the other hand, our estimated results do not show an effect of formal education on the distribution of future food consumption, as suggested by Schultz (1975). Schultz's hypothesis suggests that educated individuals are less vulnerable; they adapt more easily to changing circumstances. It may be that because of the generally low level of education, there is not enough variation in the variable to measure its effect with any confidence.

Possibly puzzling result is the correlation of drought shock and level of food consumption. The level of food consumption is strong and positively correlated with drought shock. This seems counter intuitive; nevertheless, this could possibly be due to well established relief assistance in the region and high calorie content in the food items like oil and wheat provided by relief assistance. Indeed around one fourth (24% of 2444) of the sampled households have received oil as aid.

This study also uncovered that households in south eastern zone have significantly lower expectation and larger variance of future food consumption. Furthermore, households in eastern zone have significantly higher expectation of future food consumption and higher variance of

food consumption. Thus we can say that households in south eastern zone are more vulnerable to food insecurity than households in the other zones of the region. Although, variance of food consumption for households in north western zone are significantly higher than that of households in the other division, any significant evidence is not found about lower expectation of future food consumption for these households.

4.3 Extent of Vulnerability to Food insecurity

Based on the estimation results for mean (Table4.5, col. 1) and the above estimated variance (Table4.5, col. 2) one can compute the level of vulnerability to food inadequacy for each household. A household is then considered highly vulnerable to food insecurity if its vulnerability level exceeds some threshold, in our case this is, following, Chaudhuri (2003), 0.5. Based on this a vulnerability profile for rural Tigray is estimated. As discussed in detail in the methodology part due to lack of panel data representative of the study area for ideal vulnerability analysis a methodology of vulnerability to food insecurity proposed by capaldo et al. (2010) for cross sectional data is adopted. Consequently vulnerability figures are approximate figures and they should be interpreted accordingly.

Vulnerability to food insecurity computed as a probability to fall, or stay, below a given food security threshold in the next period. Because vulnerability is linked to the uncertainty of events, everyone is vulnerable to food insecurity, but some more so than others. Using the method specified in the methodology part of this thesis vulnerability index for each household is estimated. Following the regression analysis, the vulnerability indicator (equation 5) is computed using predicted kilocalorie consumption and its variance for each household. The average probability for a household to fall below the food security threshold is about 0.38. After computing vulnerability index for each household, households with vulnerability index greater or equal to 0.5 are grouped as high vulnerable group and households with vulnerability index less than 0.5 are grouped as low vulnerable group.

Table 4.6: Cross distribution of food insecurity and vulnerability to food insecurity in rural Tigray. (Population shares and, in brackets, average probability of a household's future food insecurity status, v_h)

Current status	Highly Vulnerable V_h>=0.5		Low Vulnerable V_h<0.5		Total	
Food secure	14%	[0.78]	48%	[0.12]	62%	[0.27]
Food insecure	23%	[0.81]	15%	[0.21]	38%	[0.57]
total	37%	[0.79]	73%	[0.14]	100	[0.38]

**note numbers in parenthesis are average probability of vulnerability*

Source; own computation based on TRBSS (2011) data

Table 4.6 shows that a sizable fraction of food secure is vulnerable to food insecurity in future. Indeed, of the 62% of the population observed to be food secure, 14% are estimated to be vulnerable to food insecurity in future also. Moreover, about 15% of the sample households are currently food insecure but observed to be able change their situation. Overall, in rural Tigray 37% of households are highly vulnerable to food insecurity, exhibiting an average vulnerability of 79%.The implication of this is that there is a need to give greater emphasis for prevention as now has been recognized as a strategy to achieve food security. As part of social protection agenda setting up information system to monitor social groups that are highly vulnerable is required. In effect this will facilitate safety net programs targeting that aimed to maintain adequate level of food consumption and improve food security. This in turn prevents the vulnerable households from adopting damaging strategies and depleting their assets. As Devereux et al. *(*2008) pointed out effective safety net programmes alleviate liquidity constraints for smallholders, boost demand for farm products, foster income generating strategies, and create multiplier effects throughout the local economy.

4.3 .1 Categorization of food insecurity in to different groups

With an assumption of cross sectional variability proxies inter-temporal variation in food consumption, a regression model was used to estimate the relationship between households' food consumption level and its characteristics and hetroscedacticity is allowed. This model is used as a basis for assessing vulnerability to food deprivation. Following the regression analysis, the vulnerability indicator is computed using predicted kilocalorie consumption and its variance for each household. Using the vulnerability index obtained from the model and current food security status food security status is decomposed in to four different categories.

Table 4.7: Categorization of food insecure in different groups

Food security category	Number of house holds	Percent
Permanent food secure	1175	48.07
Transitory food secure	336	13.76
Transitory food insecure	367	15.01
Permanent food insecure	566	23.16

Source; own computation based on TRBSS (2011) data

As table 4.7 shows only 48.07% of households enjoy stable levels of food security in the sample; that is they are food secure and low vulnerable. On the other hand, 23.16% of the population is undernourished (food insecure) while also being highly vulnerable; these are considered chronically food insecure.15.1% of households are currently undernourished but only temporarily (transient food insecure). Most importantly, about 13.76% of households in the sample are food secure at present, while being at risk of being undernourished (food insecure) in the future. Therefore, in the case of rural Tigray targeting error (exclusion error) could potentially affect around one third of the population (15.01%+13.76%=28.77%).

It is evident from the above fact that around one third of the sampled rural population is in a transitory condition, falling in and out of food insecurity, while two thirds are found to be in a stable condition, being either food secure or food insecure. Food security oriented policies based on a static analysis of food security (emphasizing current

vulnerability) may not capture the forthcoming needs of a large share of the population, while targeting households whose needs are of a temporary nature only.

There are obvious advantages in further disaggregating food security categories as in Table 4.6 rather than simply dividing households into the food insecure and food secure. This disaggregation clearly demonstrates that the food insecure and the vulnerable are heterogeneous rather than static homogenous groups. Hence, it will facilitate advocacy and allow monitoring of progress in reducing vulnerability. In addition, each one of these groups is likely to respond differently to particular policies aimed at reducing food deprivation and vulnerability and as such, it might be necessary to devise different policies for different groups.

4.3.2 Vulnerability to food insecurity among different socio economic characteristics

Table 4.8 depicts the predicted food insecurity status of rural households in Tigray. The columns show both the predicted and observed food insecurity as well as the vulnerability to current food insecurity ratios. The geographical distribution of observed food insecurity profile shows that the southern zone of the region is the most food insecure while the western zone of the region is the least food insecure. But the southeastern zone has the highest level vulnerability to food insecurity while the western zone has the least vulnerability level. The relativity of vulnerability to the observed food insecurity level shows that for every food insecure people in the southeastern zone, around 58 more are expected to be food insecure in the future. The same trend is observed in the southern zone. On the other hand, people are expected to move out of food insecurity in the western, and the eastern zone in the future.

Table 4.8: Vulnerability/Observed food insecurity Profile of rural households in Tigray by Demographic/Socio-economic Characteristics

Demographic /socio economic characteristics	**Vulnerable (expected food insecurity)**	**Currently food insecure (incidence of food insecurity)**	**Vulnerable/currently food insecure ratio**
Zone			
central	.3733333	.3883333	0.961373
eastern	.2361702	.3787234	0.623595
North western	.3147321	.375	0.839286
southeastern	.6172107	.3916914	1.575758

western	.1658291	.2864322	0.578947
southern	.474359	.4230769	1.121212
Education level of the household head			
illiterate	.3378016	.3941019	0.857143
Religious/traditional	.6823529	.3882353	1.757576
Primary education	.3846154	.3675214	1.046512
Secondary &/above education	.15	.2625	0.571429
Main activity of the head			
Farming	.3760946	.3857268	0.975028
Non farming	.26875	.325	0.826923
Gender			
Male	.4063339	.4004294	1.014745
Female	.2495697	.3218589	0.775401
Age of the house hold head			
20 or less	.125	.25	0.5
21 to 40	.2945493	.3176101	0.927393
41 to 60	.4666031	.4532443	1.029474
61 and above	.3018433	.3525346	0.856209
Family size			
1 man household	.220339	.0677966	3.250001
2 to 6	.2409714	.3156912	0.763314
7 to 10	.6343085	.5398936	1.174877
above 10	.9259259	.5925926	1.5625

Source; own computation based on TRBSS (2011) data

The food insecurity profile ratio by educational qualification shows that human capital is a key factor to mitigating vulnerability to food insecurity. The observed food insecurity level shows that incidence of food insecurity is highest in the households without education. The vulnerability trend is somehow different to the observed food insecurity. More importantly however, is that,

fewer people are expected to be vulnerable relative to the observed (actual) food insecurity for households with secondary and/or above education. Households with heads with religious/ traditional education are prone to food insecurity. Indeed, additional 75 households in this category are expected to be food insecure with every 100 currently food insecure households. The possible reason for this could be because of many religious holy days celebrated by this house hold.

The incidence of food insecurity by occupational leaning indicates higher level of food insecurity among farming households whether predicted or observed. However, more people are expected to move out of food insecurity among non farming households in the future. Gender wise, both male and female headed households are vulnerable to food insecurity but male headed households are more vulnerable.

The age categorization of vulnerability to food insecurity ratio indicates that in the households headed by age-group 41-60, higher numbers of households are expected to be food insecure in the future. While, fewer households in the other age groups will be food insecure in the future. Households with large family size are more prone to be food insecure in future. As household size increases, the vulnerability to food insecurity ratio will increase. Indeed, for households with more than six members, more members of these households will become food insecure in the future. Specifically, for every 100 food insecure households, 17 and 56 more households will become food insecure for households size ranges from 7-10 and above 10 respectively in the future.

4.4 Correlates of vulnerability to food insecurity

The estimation of the vulnerability to food insecurity measures (v_h) requires knowledge of the ex ante probability distribution of the household's future consumption. A caloric threshold is required to classify a household as food secure or insecure; one must also specify a probability threshold. In this study the ex ante probability distribution of each household's future food consumption is obtained from the estimated results. Assuming log normality, a prediction of each household's ex ante mean and variances of logarithmic caloric consumption per adult equivalent are sufficient to characterize a household's ex ante probability distribution of future consumption. They are

obtained by substituting the values of the explanatory variables for that household into the equations in table 4.5. Having knowledge of each household's probability distribution, combined with a caloric threshold, allows us to calculate each household's probability of shortfall (v_h).

Vulnerability estimation made using the available cross section data revealed that (902 or 37%) out of the total 2444 rural sampled households are vulnerable to food insecurity in the study area. These huge numbers of people are at risk of failure to meet the minimum calorie requirement for healthy life. This is to mean that they could not produce enough or they don't have other way to stand with shortage in agricultural production to satisfy their daily minimum requirement of food consumption. So finding factors that contribute to vulnerability to food insecurity goes beyond the descriptive analysis and requires employing econometric analysis. For this end, multivariate econometric analysis enables us to identify influencing factors of vulnerability to food insecurity. As discussed in the methodology part of this study, a logit model is estimated to identify influencing factors of vulnerability to food insecurity. The advantage of using this model is ease of specification and estimation.

To scrutinize the determinants of vulnerability to food insecurity the measure of vulnerability is used to classify households as highly vulnerable and low vulnerable. When vulnerability estimate is greater than or equal to 0.5 the house hold is grouped as highly vulnerable which takes 1 and 0 otherwise (when the vulnerability estimate is less than 0.5) regressed on the set of house hold characteristics. Descriptive statistics of the variables used in the logit model are as shown in appendix table 2. The following section presents evidence on the influencing factors of vulnerability to food insecurity.

Using the vulnerability indicator, which takes 1 if the household is highly vulnerable and 0 if the household is low vulnerable, and the explanatory variables the model was estimated following maximum likelihood procedure. The measurement of goodness of fit of the model shows that the model fit the data well. Moreover, the model is significant at1% level of significance and the pseudo R^2 indicates that the model predicts vulnerability to food insecurity well. Therefore, based on of the chosen threshold of vulnerability to food insecurity we look through factors that influence house hold to be highly vulnerable.

Table: 4.9 Logistic estimation result of influencing factors of vulnerability (robust standard errors in parenthesis).The dependent variable is dummy vulnerable which takes 1 if highly vulnerable and 0, for low vulnerable.

EXPLANATORY VARIABLES	coefficient	Marginal effect dy/dx
Age of the house hold head	0.0572*	.0121848 *
	(0.0294)	(.00624)
Age square	-0.000510*	-.0001086 *
	(0.000289)	(.00006)
Family size	0.611***	.1301734 ***
	(0.0361)	(.00773)
Land owned per adult equivalent	-0.399***	-.0850687***
	(0.119)	(.02475)
Number of livestock in TLU	-0.0956***	-.0203611***
	(0.0206)	(.00437)
Head educated up to secondary&/above	-0.647*	-.1202115 **
	(0.393)	(.0613)
Main Occupation farming	0.173	.0357015
	(0.253)	(.05047)
Sexhead (male)	-0.192	-.0416958
	(0.145)	(.03213)
Illness shock	0.504	.1158148
	(0.350)	(.08485)
Central zon1	-0.791***	-.7907657***
	(0.170)	(.1696892)
Eastern zon2	-1.693***	-.2792144 ***
	(0.187)	(.0224)
North western zon3	-1.054***	-.1920999***
	(0.182)	(.02782)
South eastern zon4	0.842***	.195181***
	(0.191)	(.04657)
Western zon5	-1.764***	-.258238 ***
	(0.256)	(.02286)
improved seed user	-0.387***	-.0786649 ***
	(0.129)	(.02499)
Fertilizer user	-0.124	-.0268179
	(0.146)	(.03187)

Participation in food security package	-0.183	-.0381807
	(0.123)	(.02505)
Irrigation use	-0.0676	-.0142606
	(0.143)	(.02982)
Sold asset as coping mechanism	0.113	.0244895
	(0.158)	(.03467)
Consumed seed from own store as coping	-0.283**	-.0589142 **
	(0.118)	(.02416)
Constant	-3.799***	
	(0.705)	

Number of Observations			2,442
Log pseudolikelihood = -1164.2381	Wald chi2(20)	=	475.18
	Prob > chi2	=	0.0000
	Pseudo R2	=	0.2756

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source; own computation based on TRBSS (2011) data

The coefficient of Age of the household head is positive and significant at 10% level of significance implying that on average as the household head gets older the probability of being vulnerable to food insecurity increases. But this effect weakens with age as we see from negative and significant coefficient on age square. This shows that increment of age after some point reduces the probability of being vulnerable to food insecurity. This result is as expected since older households are the ones with better experience in agriculture and possibly with accumulated wealth that could be used as buffer stock whenever faced food shortage. Moreover as argued in section 4.2 of this thesis it is natural to expect diversified income portfolio for older households.

As one expects family size has positive and significant effect at 1% significance level on the probability of being highly vulnerable to food insecurity. Since larger family size means many mouths to share the available food. This shows that households with larger family size are more prone to be food insecure in future (vulnerable). This may be because food, a rival good, tends to represent a substantial share of the budget of the poor (Lanjouw & Ravallion, 1995). In addition, there are high risks of declining soil productivity in a subsistence economy where large

household size is likely to increase competition for land use between cash crops and food crops (Abuka et al., 2007). This decline in soil productivity may result in long run food insecurity, as it may lead to low output levels, and, consequently, high risks of being consumption poor.

Substantial evidence shows that households subject to income shocks and facing imperfect insurance markets use their assets to maintain smooth consumption (Deaton, 1992). Household assets include livestock, farmland, jewelry, etc and can be used to smooth consumption either by borrowing against them or by liquidating them. A familiar asset used for consumption smoothing in developing countries particularly in SSA is livestock (Fafchamps et al., 1996). For example Rosenzweig and Wolpin (1993) present compelling evidence that sales and purchases of livestock are used as consumption smoothing strategies. Kinsey et al. (1998) found that during the four droughts occurred in rural Zimbabwe over the period 1983-96, the most common self insurance form used to smooth consumption is the sale of cattle.

In line with the above strand of literature, evidence is found that ownership of assets such as land and livestock has negative and significant effect on the probability of high vulnerability to food insecurity. The ownership of livestock is highly statistically significant though the impact seems to be quite marginal. The marginal effect shows that a one unit increase in livestock number in (TLU) from mean holding (3.75) to (4.75) decreases the probability of food vulnerability in the future by 2 percent keeping all other things constant. This might not be surprising in the sense that additional ownership of livestock has to be complemented with other resource if aimed to reduce food vulnerability.

Not surprisingly, land owned per adult equivalent by the household put a strong impact on food vulnerability with a high statistical significance. Table 4.9 indicates that one tsimad increase in land leads to around 8.5 more likelihood for a household to be food secure.

The coefficient on the dummy variable for education level of the household head up to secondary&/above is negative and statistically significant at 10% level. This implies that the probability of being food insecure in future is lower for those households headed by educated up to secondary&/above. As results depict in table 4.9 household heads education up to secondary&/above reduces the probability of being highly vulnerable to food insecurity by 12 percent. This is basically linked to better awareness of educated households to improved farm technologies and other livelihood opportunities than the illiterate households. As one possibly

expects the result shows human capital is a key factor to mitigating vulnerability to food insecurity.

Once again the logistic regression result also confirmed that households who live in south eastern zone have higher probability of vulnerability to food insecurity than any other zone in rural Tigray. The coefficient on the dummy for usage of improved seed is negative and highly statistically significant even at 1% level. This shows the probability of being vulnerable to food insecurity is lower for those households who use improved seed. Implying that the effectiveness of agricultural technologies in reducing vulnerability to food insecurity.

As shown by negative and statistically significant coefficient on a dummy variable for consumption of seed as coping mechanism, the probability of being vulnerable to food insecurity is lower for those households who consume seed from their store than those used other coping mechanisms.

Chapter Five: Conclusion and Recommendation

This chapter presents summary of main findings of the study and policy implications based on the findings.

5.1 Conclusions

This study examines the food security and vulnerability situation of rural households in Tigray region, Ethiopia. Also some of influencing factors of vulnerability to food insecurity. Descriptive analyses, multivariate analysis and vulnerability estimation using cross section data were used in the study. Based on the data from TRBSS (2011) main findings of the study are as followed.

The problem of food insecurity is extensive in the study area. Among the sampled households in rural areas of Tigray region 38.18% were found to be food insecure (933 out of 2444) where as 61.82% of the households were found to be food secure. Mean acquired kilocalorie per day per adult equivalent for food insecure households is (1612.42) kilocalorie which is below the minimum required level (2200 kilocalorie). This implies that, on average, the food insecure far below the minimum threshold by 587.58 kilocalories.

With an assumption of cross sectional variability proxies inter-temporal variation in food consumption, a regression model is used to estimate the relationship between households' food consumption level and its characteristics and hetroscedacticity is allowed. Following the regression analysis, the vulnerability indicator is computed using predicted kilocalorie consumption and its variance for each household. Vulnerability estimation made using the available cross section data revealed that 36.9% (902) out of the total 2444 rural sampled households are highly vulnerable to food insecurity in the study area with an average probability of 0.79. These huge numbers of people are at risk of failure to meet the minimum calorie requirement for healthy life. The average probability for a household to fall below the food security threshold in the study area is about 0.38 (38 percent).

Households identified as food insecure by standard cross-section methods are more heterogeneous than they come into view at first sight. For instance, a number of food secure households are at high risk of falling into food insecurity in the next period, i.e. they have high

vulnerability. On the other hand, some households below the food security threshold at a point in time are low vulnerable, and their observed food shortage reflects a transient deprivation spell.

Categorization of food insecurity shows that, only 48.07% of households enjoy stable levels of food security in the sample; that is they are food secure and low vulnerable. On the other hand, 23.16% of the population is undernourished (food insecure) while also being highly vulnerable; these are considered as chronically food insecure. 15.1% of households are currently undernourished but only temporarily (transient food insecure). Most importantly, about 13.76% of households in our sample are food secure at present, while being at risk of being undernourished (food insecure) in the future. Therefore, in the case of rural Ttargeting error (exclusion error) could potentially affect a round one third of the population (15.01%+13.76%=28.77%).

The vulnerability estimates of households in the region indicate that there are a substantial proportion of households vulnerable to food insecurity. The results are highly heterogeneous across the zones, reflecting the differing socioeconomic conditions in each zone. Evidence from profiles also highlighted some of the characteristics distinctly related to vulnerability, such as residence in south eastern zone, larger family size relatively smaller farm size per adult equivalent and low education of the household head.

Both idiosyncratic and covariate factors affect level of food consumption of rural households in Tigray region. The key covariate factor significantly associated with household's food consumption in rural tigray is the residential location of households. On the other hand, household size, age of household head, and ownership of land and education status of household heads are idiosyncratic factors that are significantly correlated with rural household food consumption in Tigray. The rural southern zone of Tigray constitutes the most food insecure zone while the western zone of Tigray is the least food insecure. But the southeastern zone has the highest level of vulnerability to food insecurity while the western zone has the least vulnerability level.

Households with heads without education recorded the highest incidence of food insecurity. More importantly however, is that, fewer people are expected to be vulnerable relative to the observed (actual) food insecurity for households with secondary and/or above education. There is an evidence of higher level of food insecurity among rural farming households (whether predicted or observed) when compared to their rural non-farming households' counterpart.

The age categorization of vulnerability to food insecurity ratio indicates that in the households headed by age-group 41-60, higher numbers of households are expected to be food insecure in the future. While, fewer households in the other age groups will be food insecure in the future. Households with large family size are more prone to be food insecure in future. As household size increases, the vulnerability to food insecurity ratio will increase.

This study has also examined the determinants of vulnerability to food insecurity using logistic regression. Most of the findings in descriptive analysis are consistent with the results of logistic regression model. From the logistic regression model it is found that factors such as land ownership, livestock ownership, and heads education up to secondary&/above, residential zone and use of improved seed reduce significantly the likelihood of vulnerability to food insecurity. Larger family size positively affects the probability of vulnerability to food insecurity.

5.2 Recommendations

For interventions designed to reduce vulnerability to food insecurity in the study area findings of this study have important implications. The vulnerability rate is highly heterogeneous across the zones, the south eastern zone ranking the first place. This result suggest that the need for geographical targeting to reach out the most vulnerable. Moreover, the implications for policy arising from this study's conclusion are substantial. Accordingly, the following recommendations are as relevant:

The appropriate zone specific policy to alleviate vulnerability to food insecurity in the rural central and eastern zone of the region is consumption smoothening strategies. While, raising per capita food consumption of rural households in the rural south eastern and north western zones should be combined with consumption smoothing as the key mitigating factors against vulnerability to food insecurity. This is so because the sources of vulnerability in these two zones are both systematically lower level of food consumption and significantly higher variability in food consumption.

In designing policies it is worth noting the varying nature of observed food insecurity and vulnerability. These highly interrelated but different dimensions of welfare have policy implication. Therefore ex ante measures should be enhanced to prevent households from

becoming food insecure alongside ex post measures to alleviate food deprivation. Accordingly food security strategies need to lay emphasis on prevention.

Comprehensive human capital development policy is a key factor that can be used to mitigate high level of vulnerability to food insecurity among rural households. This is so since findings have shown household heads education especially up to secondary &/above level significantly reducing the likelihood of vulnerability to food insecurity. Moreover, an aggressive family planning policy is considered necessary to allay against high level of vulnerability to food insecurity among rural households. This is so since findings have shown that as household size increases, the more they are vulnerable to food insecurity.

To achieve food security in the region as it has been stated in the recently developed growth and transformation plan for the period (2011-2015) through increasing agricultural productivity greater emphasis should be given to improved seed technology development and disseminations as results from this study points out improved seed plays significant role in reducing vulnerability of the households.

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Appendix

Appendix table 1: table of conversion factors used in food consumption estimation

Food item	kcal/100 gram
Teff	341
Barley	354
Wheat	351
Karka'eta*	352
Maize	362
Sorghum	347
Lentil	353
Bean	344
Fieldpeas	341
Chickpeas	364
guaya	347
Finger milet	312
Coffee	2
Sugar	400
Berbere	318
Salt	0
Oil	884
Onion	42
Garlic	149
Potato	87
Tomato	18
Milk	39
chease	132
Beef	235
chicken	140
Egg	68

**note for karka 'eta (a mix of wheat and barley)we used average of calorie content of the two*

Source: Ethiopian Nutrition and Health Research Institute (ENHRI) and world health organization(WHO)

Appendix table 2: Descriptive statistics of variables used in logistic regression

Variable	Obs	Mean	Std. Dev.	Min	Max
Head age	2442	47.28706	14.12813	14	90
Head age square	2442	2435.588	1435.653	196	8100
Family size	2444	5.373159	2.222174	0	12
land_paequ	2444	.9175878	1.001754	0	12.19512
Number of livestock(TLU)	2444	3.746461	3.743843	0	41.7
Secondary &/above secondary educated head	2444	.0327332	.1779739	0	1
farming	2444	.9345336	.2473977	0	1
sexhead	2444	.762275	.425777	0	1
Illness shock	2444	.0282324	.1656701	0	1
zon1	2444	.2454992	.4304709	0	1
zon2	2444	.1923077	.3941941	0	1
zon3	2444	.1833061	.3869964	0	1
zon4	2444	.1378887	.3448537	0	1
zon5	2444	.0814239	.273541	0	1
improved_s~d	2444	.2119476	.4087716	0	1
fertilizer_use	2444	.7999182	.4001432	0	1
Participation in food security package	2444	.2131751	.4096342	0	1
irriga_use	2444	.1358429	.3426918	0	1
Sold asset	2444	.1378887	.3448537	0	1
Consumed seed	2444	.3158756	.4649588	0	1

Source own computation based on TRBSS(2011)data

Appendix Table-3: Conversion factors for livestock

Livestock type	**Tropical Livestock Unit (TLU)**
Ox/cow	1.00
Heifer	0.75
Calf	0.20
Horse/mule	1.10
Donkey	0.70
Donkey (young)	0.35
Sheep/goat	0.13
Sheep/goat (young)	0.06
Camel	1.25
Chicken	0.013

Source: Storck *et al*., (1991)

```
-------------------------------------------------------------------------------
      name:  eyobfinal
       log:  C:\Users\admin\Desktop\vulnefinalresult.log
  log type:  text
 opened on:   1 May 2012, 10:29:00

. logit  vulnerable  q1_1_4agea agesqu  tot_family_size1  land_paequ
numberoflivestockintlu educ4 farming sexhead illn
> ess zon1 zon2 zon3 zon4 zon5 improved_seed fert_use q6_2_3fsp irriga_use
_6_1_6_soldass _6_1_6_conseed , nolog robust

Logistic regression                               Number of obs   =       2442
                                                  Wald chi2(20)   =     475.18
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -1164.2381                 Pseudo R2       =     0.2756

------------------------------------------------------------------------------
             |               Robust
  vulnerable |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  q1_1_4agea |   .0572046   .0293874     1.95   0.052    -.0003936    .1148028
      agesqu |    -.00051   .0002887    -1.77   0.077    -.0010758    .0000559
tot_family~1 |   .6111297   .0360835    16.94   0.000     .5404073    .6818521
  land_paequ |  -.3993748   .1191611    -3.35   0.001    -.6329263   -.1658233
numberofli~u |  -.0955899   .0205652    -4.65   0.000     -.135897   -.0552828
       educ4 |  -.6472987   .3928696    -1.65   0.099    -1.417309    .1227117
     farming |   .1727765   .2525644     0.68   0.494    -.3222406    .6677937
     sexhead |  -.1921773   .1453549    -1.32   0.186    -.4770676     .092713
     illness |    .504398   .3497613     1.44   0.149    -.1811215    1.189918
        zon1 |  -.7907657   .1696892    -4.66   0.000     -1.12335    -.458181
        zon2 |  -1.693182    .186945    -9.06   0.000    -2.059588   -1.326777
        zon3 |   -1.05397   .1824459    -5.78   0.000    -1.411558   -.6963828
        zon4 |   .8417917   .1913069     4.40   0.000     .4668372    1.216746
        zon5 |   -1.76353   .2559601    -6.89   0.000    -2.265203   -1.261857
improved_s~d |  -.3870242   .1294196    -2.99   0.003    -.6406819   -.1333666
    fert_use |  -.1241688    .145565    -0.85   0.394    -.4094709    .1611333
   q6_2_3fsp |  -.1830747   .1227009    -1.49   0.136    -.4235639    .0574146
  irriga_use |  -.0675996   .1426753    -0.47   0.636     -.347238    .2120388
_6_1_6_sol~s |   .1132317   .1579862     0.72   0.474    -.1964156     .422879
_6_1_6_con~d |  -.2825682   .1184435    -2.39   0.017    -.5147132   -.0504232
       _cons |   -3.79857   .7049328    -5.39   0.000    -5.180213   -2.416927
------------------------------------------------------------------------------
```

```
. mfx

Marginal effects after logit
      y  = Pr(vulnerable) (predict)
         =   .3076581
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
q1_1_4~a |   .0121848      .00624    1.95   0.051  -.000036  .024406   47.2871
  agesqu |  -.0001086      .00006   -1.77   0.076  -.000229  .000011   2435.59
tot_fa~1 |   .1301734      .00773   16.85   0.000   .115028  .145319   5.37551
land_p~u |  -.0850687      .02475   -3.44   0.001  -.133573 -.036565   .916646
number~u |  -.0203611      .00437   -4.66   0.000  -.028926 -.011797   3.74816
   educ4*|  -.1202115       .0613   -1.96   0.050   -.24035 -.000073    .03276
 farming*|   .0357015      .05047    0.71   0.479   -.06322  .134623    .93448
 sexhead*|  -.0416958      .03213   -1.30   0.194  -.104661   .02127   .762899
 illness*|   .1158148      .08485    1.36   0.172   -.05049   .28212   .028256
    zon1*|  -.1538913      .02948   -5.22   0.000  -.211674 -.096109     .2457
    zon2*|  -.2792144       .0224  -12.46   0.000  -.323126 -.235303   .192056
    zon3*|  -.1920999      .02782   -6.90   0.000  -.246632 -.137567   .183456
    zon4*|    .195181      .04657    4.19   0.000   .103915  .286447   .137592
    zon5*|   -.258238      .02286  -11.30   0.000  -.303041 -.213434   .081491
improv~d*|  -.0786649      .02499   -3.15   0.002  -.127642 -.029688   .212121
fert_use*|  -.0268179      .03187   -0.84   0.400   -.08928  .035644   .800573
q6_2_3~p*|  -.0381807      .02505   -1.52   0.128  -.087286  .010924    .21335
irriga~e*|  -.0142606      .02982   -0.48   0.632  -.072698  .044176   .135545
_6_1_6~s*|   .0244895      .03467    0.71   0.480  -.043467  .092446   .138002
_6_1_6~d*|  -.0589142      .02416   -2.44   0.015  -.106267 -.011561   .316134
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

```
-------------------------------------------------------------------------------
      name:  eyob2012
       log:  C:\Users\admin\Desktop\specificationtest.log
  log type:  text
 opened on:   3 May 2012, 10:42:03
. **the following is model specification test
. linktest

Logistic regression                               Number of obs   =       2442
                                                  LR chi2(2)      =     887.25
                                                  Prob > chi2     =     0.0000
Log likelihood = -1163.6495                       Pseudo R2       =     0.2760

------------------------------------------------------------------------------
  vulnerable |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |    1.02517   .0501651    20.44   0.000     .9268486    1.123492
      _hatsq |    .027057   .0247325     1.09   0.274    -.0214178    .0755319
       _cons |  -.0317465   .0611974    -0.52   0.604    -.1516912    .0881982
------------------------------------------------------------------------------
```

The thing to look for here is the significance of _hatsq. The null hypothesis is that there is no specification error. If the p-value of _hatsq is not significant then we fail to reject the null and conclude that our model is correctly specified.

```
name:  Eyob2012
       log:  C:\Users\admin\Desktop\testformulticolinearity.log
  log type:  text
 opened on:   9 May 2012, 11:17:17


. vif

    Variable |       VIF       1/VIF
-------------+----------------------
  q1_1_4agea |     52.51    0.019045
      agesqu |     52.30    0.019122
        zon1 |      2.16    0.464036
        zon3 |      2.04    0.489375
        zon2 |      2.02    0.495452
tot_family~1 |      1.83    0.547042
        zon4 |      1.70    0.587494
        zon5 |      1.58    0.633815
     sexhead |      1.39    0.720503
numberofli~u |      1.31    0.765853
  land_paequ |      1.30    0.768927
_6_1_6_con~d |      1.19    0.841133
    fert_use |      1.19    0.843324
improved_s~d |      1.15    0.868968
_6_1_6_sol~s |      1.14    0.880521
     farming |      1.11    0.898858
       educ4 |      1.07    0.931064
   q6_2_3fsp |      1.06    0.945607
  irriga_use |      1.04    0.957426
     illness |      1.03    0.973634
-------------+----------------------
    Mean VIF |      6.50
```

An important assumption for the multiple regression models is that independent variables are not perfectly multicolinear. This is, one regressor should not be a linear function of another.(see Stock and Watson, 2003, chapter 5). A major problem with multicollinearity is that standard errors may be inflated. A vif > 10 or a 1/vif < 0.10 indicates trouble. We know that age and age square are related since one is the square of the other. They are ok since age has a quadratic relationship with the dependent variable. For the rest of variables vif <10 and 1/vif of >0.1.so we are ok here.