Determinants of Food Security in Rural Farm Households in Ethiopia

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List of Acronyms

AAU	Addis Ababa University
ADLI	Agricultural Development led industrialization
CSA	Central Statistical Agency
CSAE	Center for the Study of African Economies
DFID	Department for International Development
EHNRI	Ethiopian Health and Nutrition Research Institute
ERHS	Ethiopian Rural Household Survey
ESRC	Economic and Social Research Council
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
FE	Fixed Effect
FSP	Food Security Program
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HDI	Human Development Index
IFPRI	International Food Policy Research Institute
MDG	Millennium Development Goal
MoARD	Ministry of Agriculture and Research Development
MoFED	Ministry of Finance and Economic Development
NNP	National Nutrition Program
PA	Peasant Association
PPP	Purchasing Price Parity
PRB	Population Reference Bureau
PSNP	Productive Safety Net Program
RE	Random Effect
SIDA	Swedish International Development Agency
SNNPR	Sothern Nations Nationalities and peoples region
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USD	United States Dollar
WFP	World Food Program

Abstract

Literatures on determinants of food security in rural farm households in Ethiopia are region specific based on cross sectional data. Studies that examine these determinants covering at least two regions remain scarce. Using panel data from ERHS, collected from four different regions, and controlling for *woreda* (district) heterogeneity the current study analyzes the determinants of food security in rural farm households in Ethiopia. Nutritional status or sufficiency of calories intake is also analyzed as a sub component.

Conditional logit and fixed effect models are used to refer to the significant determinant variable as these models basically capture the panel nature of the data. Thus, based on the results of the conditional logit model, among the priority variables fitted in to it, rainfall shock and household size negatively and significantly determine food security. While farmland size, land quality and credit access positively and significantly determine food security at varying levels of significance. In the fixed effects model these same sets of variables significantly determine nutritional status in the same sign as they determined food security with only differences in magnitude and significance of the coefficient estimates. Additionally, off farm income, fertilizer use and oxen ownership are priority variables that are found to be significant in this model. The results of the ordered probit model also reinforce the findings in the two models with only differences in magnitude and significance.

Examination of food security status indicated that majority of the farm households are food insecure. In fact there is some improvement over time, even if that is not that much significant. Analysis of regional mean values for food secured households suggested that, majority of the households in Tigray region experienced rain fall shock and occupied infertile land than other regions else. Hence, even the food secured farm households in Tigray region seemed only marginally secured.

For a better endurance to the adverse consequences of entitlement failure to the identified determinant factors, sound policy interventions must take in place. Policies on the areas of irrigation, climatic adaption strategies, land improvement, relocation and resettlement and other related interventions are "externalities" to the farm households. However, as farm households are decision makers who want to maximize their wellbeing, interventions should consider the net benefit to them. Besides, policies should start from the more disadvantaged area.

Relevance to Development Studies

A country's development and economic growth targets can be achieved by human capital. Healthy generation and human capital are closely interlinked with people having enough to eat, free from hunger and securing their daily demand for at least basic needs. So when we talk about every aspect of development food security comes at the forefront.

Ensuring food security is not a stand-alone concept. It is an interrelated concept with plant and animal biodiversity, environmental sustainability, water and soil conservation, social and behavioral factors, macro-economic situation and much more. Thus, efforts to strengthen and emphasize all these factors start with the need to ensure food security. In such a way, when we are dealing with food security we are also dealing other related problems in a collaborative manner. This allows food security and other development factors to go hand in hand.

In Ethiopia, where the majority of the country's GDP and foreign currency is contributed by the small scale farm households, ensuring food security of rural farm households is not only a key to subsist the specific farm household but also a means to growth and development of the country in general. Taking in to consideration all these issues, focusing on food security of the rural farm household is really worth emphasizing and should be a number one priority.

Key Words

Food security, determinants, households, per capita calorie intake, sufficiency of calorie intake

Chapter 1: Introduction

This study attempts to analyze the determinants of food security in rural farm households in Ethiopia. Identifying and addressing determinant factors is vital to avert threats to ensure food security. Determinants of sufficient calorie intake or nutritional status are also dealt as a sub component of this analysis.

1.1 Background

Food security and famine are at opposite extremes of a spectrum (Timmer 2000). Food security is ensured when people live without threat of starvation and hunger (Majumder et.al 2012). Examining absence of food security is the simplest way to perceive it (Rooyen and Sigwele 1998). Household food insecurity is manifested through hunger, malnutrition and undernourishment. It is a situation when the society unmet the basic needs and wellbeing for a continuous survival (Mazumdar 2012). According to Sila (2007), to continue its development, a nation requires adequate food in terms of quantity and quality for all people. Lack of food, in the long term, leads to hunger and starvation that can cause death.

Even though food insecurity is a typical disaster in developing countries, it is actually a worldwide problem that has called scientific community and governments' attention (Giraldo et al. 2008). Distress from chronic hunger is about one in every eight people in the world in 2011-2013. This figure is equivalent, in absolute terms, with 842 million people that are not obtaining adequate food to run and play active life (FAO 2013).

Fighting hunger and food insecurity is possible with economic growth which raises incomes of the population. However economic growth may not reach everyone unless pro poor policies, which specifically target the poor in the rural areas, are designed. In poor countries reduction of poverty and hunger is achieved not only with sustained but also with broadly distributed growth. Smallholder targeted policies such as increasing food availability and agricultural productivity can achieve hunger reduction even with the presence of widespread poverty (ibid).

Thus, efforts have been made by the globe to eradicate food insecurity, hunger and poverty. Millennium development goal one, hereinafter called MDG1, is adopted in September 2000 by 185 countries. MDG1 has aimed at fighting the miserable conditions of severe poverty, hunger and food insecurity as one of its eight goals. These goals are set to be achieved in 2015. The

MDG1 has a measurable objective of bringing the relative size of people below the poverty line $1.25 in purchasing price parity (PPP) down to half from what it was in 1990 (UN 2000; UNDP 2013).

Following the MDG1, the total number of population suffering from hunger went down to 842 million in 2011-2013 from what it was in 2010-12. This indicates a trend that experienced a marked reduction of about 26 million. However, this improvement mainly accounts only for the performances of Brazil, China and India. The performances of mainly these countries led the MDG to be met three years earlier than the target. The percentage of the population living on less than $1.25 a day based on 2005 PPP went down from 17.2% to 6.1%, from 60.2% to 13.1% and from 49.4% to 32.7% in Brazil China and India respectively. As a result when we look at the overall trends of developing countries, a substantial progress has been recorded contributing to the hunger target of the MDG1 (FAO 2013).

However there existed diverse experiences among the developing countries. No progress is shown by West Asia while North Africa and Sothern Asia registered slow progress. Even if a modest progress is achieved in Sub Saharan Africa region, undernourishment continues to be prevalent (FAO 2013). Figure 1 below presents this trend.

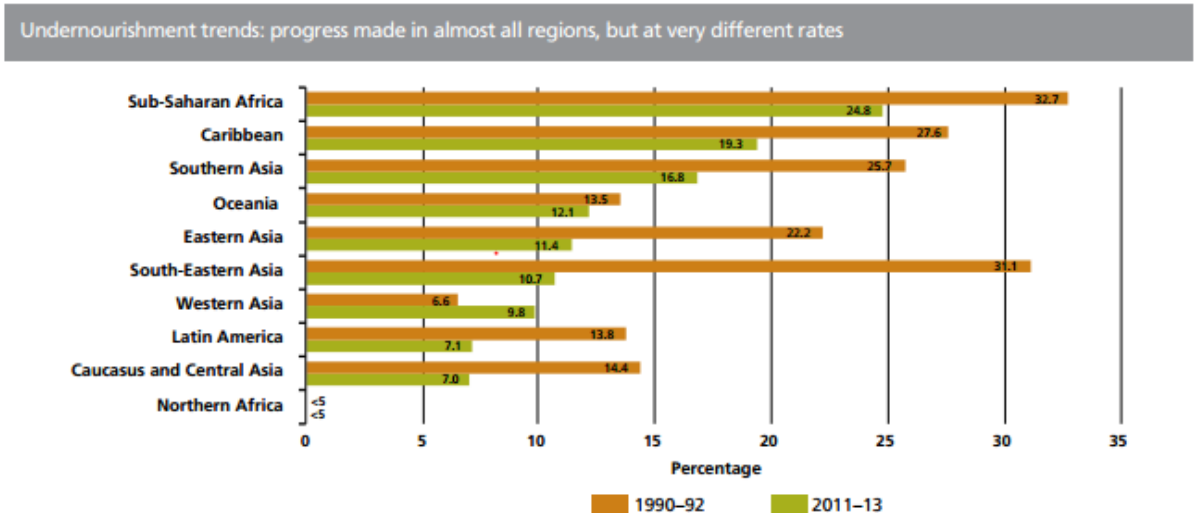


Figure 1.Undernourishment in developing countries

Source: FAO (2013)

This suggests that these countries need to do a lot to ensure food security, fight undernourishment starvation and poverty.

1.2 Overview of Food Security in Ethiopia

Ethiopia is located in the horn of Africa (appendix I presents the full map). The country is politically organized in nine ethnically-based regional states and two chartered city administration under the federal government of Ethiopia. PRB (2013) indicated that the total population of Ethiopia was 89.2 million in the middle of 2013. This actually makes Ethiopia the second most populous country in Africa next to Nigeria.

Agricultural sector is the pillar of Ethiopia's economy. Most of the agriculture is carried out in the rural areas where the rural population accounts 85% of the country's population. The sector contributes 85% of labor force employment, 90% of foreign exchange and 50% of gross domestic product. Most importantly 90% of the agricultural output is contributed by small scale farming (Abebaw et.al 2010).

According to WFP (2014) the country economy has shown fast real GDP growth of about 11% per annum during the past eight years between 2004 and 2012. Yet the poverty level in Ethiopia made it to be ranked 173rd out of 186 countries in human development index. The gross national income per capita is only USD 370 in 2011. This is less than one third of the average USD 1258 for Sub Saharan Africa countries. Devereux (2000) stated that, unlike any other country else food insecurity and poverty are overlapping in Ethiopia. One reason for this is that the government sets poverty line based on food consumption. Demeke et.al (1995) emphasized that, poverty and food insecurity in Ethiopia is mainly caused by the poor performances of agricultural sector. Policy and non-policy factors contributed to the poor performances of the agricultural sector.

Basically dependence on an undiversified livelihood and low input low output and low technological base agriculture resulted in challenge to ensure food security. Even in good rain fall years Ethiopian farmers do not produce enough food to meet consumption needs. Besides, policies that focus on agricultural intensification are misguided due to fragile natural resource base and climatic uncertainty. Inflexible land tenure is also one among the variety of issues which perpetuate the challenges to ensuring food security (Devereux 2000).

To boost household's long term resilience to food shortage the government of Ethiopia in collaboration with development partners established Productive Safety Net Program (PSNP) in 2005. PSNP targeted at capacity building of the poor in the rural areas who were exposed to

chronic food insecurity. The program helped them to create assets, resist shocks and become self-sufficient (WFP2013).

Recently, following Agricultural Led Development Industrialization (ADLI), Growth and Transformation Plan (GTP), a five year plan which lasts between 2010/11-2014/15, has been adopted. GTP gives importance to agriculture as a key to reduce food security challenges and as a source of economic development. It has aimed at prioritizing and strengthening small holder productivity. In an effort to meet GTP objectives Ministry of Agricultural and Research Development (MoARD) launched a program called Food Security Program (FSP) which involved the earlier PSNP as one of its sub component (Devereux 2000).

According to Pelletier et.al (1995) in the country food security has been central feature of policy and planning culture due to the perception that food security is a dominant element of nutrition policy. WFP (2013) also stated that, food energy deficient household in Ethiopia is about two in every five households. Thus, in any development effort in the country, food or nutrition security must be one of the first considerations as it is at the top of efforts to bring resilience to poor harvests and future droughts. Since the launch of the first National Nutrition Program (NNP) in 2009, Ethiopia has shown marked walks towards achieving its goals.

These all efforts, strategies and policy concerns indicate that, how much food security in the country is on the agenda and how much the small scale farm household productivity is central to both food security and nutrition security.

1.3 Statement of the Problem

MoFED (2013) reported that among the varieties of shocks Ethiopian households face, food insecurity and food price shocks are the most common ones. Demeke et.al (1995) pointed out that, despite many efforts, food insecurity is still a prominent feature of Ethiopia. Half of the food insecure population of the Sub Saharan Africa is found in Ethiopia, which is one of the seven food insecure country in Sub Sahara Africa. As pointed out above UNDP (2013) also reported, in human development index, Ethiopia ranked 173rd out of 186 countries.

Rapid population growth challenged achievement of food security and poverty reduction efforts in Ethiopia. An annual increment of two million people is a great challenge to the economy's ability to provide proper services and the environment (FAO 2012).

The rural population accounts 85% of the total population in the country. Dependency on rain fed agriculture is the prominent feature of the rural household. Harvest failure, unpredictable weather, output price fluctuations, frost, recurrent drought, pests, death of family member and /or livestock are some of the many shocks faced by the rural households that lead to food insecurity. About 78% rural households were seriously affected by harvest failure in the years before 2002 (Dercon 2002).

Thus achieving food security has been a long lived problem and history of Ethiopia due to agricultural shocks, disasters and some other observed and unobserved factors. The 1984 famine in Ethiopia, which was one of the causes of focus for the then studies and literatures in the food security area, takes everyone back to the journey the country passed. Even today, despite many efforts, the country is at the bottom of the ladder in human development index. This is indicative that the problem is still not well addressed and it has been a challenge to ensure food security.

Efforts targeting to address and fight problems of food security should start from the rural households as the livelihood of the majority of the rural population, basically depend up on agricultural output which is sensitive to natural and manmade disaster.

On the other extreme it seems a paradox to hear that Ethiopia is one among the seven fastest growing country in the world while it is also being reported that in Human Development Index (HDI) Ethiopia is at the lower level. Thus it is wise to analyze areas where Ethiopia is performing good or bad. This enables the country target and prioritizes areas which need immediate intervention. "….. an accurate assessment of food insecurity, in terms of identifying who the food insecure are as well their number, location and the underlying causes of food insecurity will enable stakeholders to design appropriate interventions" (WFP 2014:22). Due to the importance of food security for the country development and growth, in this paper we analyze the determinants of food security in rural farm households.

In relation to this, many studies and academic researches tried to identify factors determining food security of rural farm households in Ethiopia. However the majority of them are region and *woreda* (district) specific based on cross sectional data, while there are only few which used panel data. More specifically, the current study is distinct in the following important points.

- Unlike previous literatures which based up on region specific studies, the current study relies on data from four big regions. This makes the results of this study more or less country representative.
- The current study uses two year panel data while most of the literatures used cross sectional data. Using panel data enables controlling for unobserved individual heterogeneity .This contributes to ruling out biases in estimates. Besides, panel data can provide more valid results as it relies on repeated observation.
- Food security status and the determinants could be varying over time. Earlier studies and findings cannot be adapted to recent trends. The current study utilizes a two year (2004 and 2009) relatively recent panel data which can show the latest food security status of the rural farm household. Therefore it is believed that this study will be an addition to the existing literatures.

1.4 Objective of the Study and Research Question

In the field of Economics of Development, the importance of measures of development like human development index, per capita income and happiness, is to judge the safety and development of the people. For a human being to keep safe, his needs, at least, for food must be satisfied. Hence, when we talk about economic development food security comes at the forefront for safe survival.

This research is therefore aimed at empirically identifying and examining significant socio economic factors that determine the food security status of the rural farm household. Identifying factors that determine per capita per day calorie intake or sufficiency of calorie intake is also at the heart of the research. Based on econometric estimate significant factors which demand policy intervention is also supposed to be identified and analyzed. Once the significant limiting factors are identified, the study, most importantly, tries to put feasible policy options. Thus, in order to meet these objectives the study sets the following questions.

Main research question

- What socio economic variables or factors determine food security in Ethiopia?
- What socio economic variables or factors play a role in determining per capita per day calorie intake or sufficiency of calorie intake in Ethiopia?

- Among the identified sets of socio economic variables, which factors significantly determine food security and sufficient level of calorie intake?
- What should be done on these determinants (limiting factors) to prevent their adverse effect?

Sub research questions

- How many of the households in the sample are food secure and how many are food insecure?
- What is the improvement in food security status overtime?
- How many of the households in the sample are food secure, moderately secure, moderately insecure and severely insecure?
- What are the mean values of variables for food secure and food insecure households?
- What are the regional mean values for food secure households and what is the implication?

1.5 Limitations of the Study

In the notion of the concept of food security there is a time dimension when food insecurity can be chronic, cyclical or transitory. This aspect is also related to the vulnerability of the households to food insecurity. Limited by the data, this study uses average calorie intake, which only addresses availability and access dimensions of food security. Thus the time and vulnerability dimension of food security is not addressed in this study. The second limitation is, again limited by the data, the current study tried to see nutritional status only in the context of sufficiency of calorie intake.

Chapter 2: Literature Review

Providing an answer to the research questions starts with how food security is defined and how it is measured. This section gives some insight in to how food security is defined, what stages the definition of food security have gone through what are the related concepts related to it and how it is measured. Besides it also includes some insight in to sufficiency of calorie intake or nutritional status.

2.1. History of Food Security

The 1970's are important periods when the food security literatures have shown dramatic increase as a root cause of the 1972-74 world food crises. The 1948 declaration by Universal Declaration of Human Right that, at least, recognized the right to food as a main component of adequate standard of living can also be cited for the growing number of literatures in the 1970's accompanying the crisis. In these years the overall global, regional and national food supplies and shortfalls in supply were the main concern as compared to the individual requirement (Maxwell and Smith 1992).

Additionally, in the 1980's a sudden upward movement in interest in food security occurred which attributed to the 1984-85 African famine, anxiety with the worsening of basic needs during structural adjustment and fruits of intellectual progression. Intellectual progression extended through entitlement theories in the 1980's to household food security in the second half of the decade. In relation to this in the 1980's the concern of food security changed to issue of access to food at individual and household level in contrast to what it was in the 1970's which focuses on global and national food supplies as the fundamental concern of food security (Maxwell and Smith 1992).

Besides, Foster (1992) stated, the growing number of hunger in some parts while the world food scarcity disappeared in the 1980's and the presence of high food intake differences in contrary to the overall adequacy of food availability has drawn attention for a shift in thinking of food security as a global and national food supplies to access by starved people. S. Maxwell[1] (1996) also confirmed the coexistence of starvation with the presence of adequate global and national food supplies which shed light on the need for household and individual level food security

[1] According to ISS Howard referencing, initial is added as there are two authors with the same sir name and the same publication year.

analysis. Foster (1992) also pointed out that focus in 1980's was away from food production to purchasing power of the vulnerable families.

However according to Sijm (1997) the approach in defining food security 1980's as a concern of access or demand in contrast to a supply concern as it was in the 1970's raises a criticism since it undermines the significance of framers production.

Hence, Foster(1992) elaborates the shift away from production focus to purchasing power of the vulnerable families is not to disregard and devalue the importance of food production in hunger prevention. Shortage of food results in inflated food price which in turn hinders the purchasing power of the poor for adequate food supplies. Rather the shift is about the need to give awareness of the complexity of food insecurity problem that income, food production and other variables altogether affects incidence of food hunger and under nutrition.

The current paper emphasizes the relevance of the shift in the definition of food security from the national and global to the individual and household. As the whole is the sum of the parts, in order to a nation or the globe be food secured, the individual and the house hold food security is the starting point.

In the 1990s food security further incorporated the nutritional, dietary and health components as constituent elements of the definition. The 1996 Food and Agricultural organization definition of food security can be cited as a significant transition in the definition of food security in these years as compared to what it was in the 1980's.

Generally, S. Maxwell (1996:157-159) summarized three dynamic moves that have occurred to the concept of food security starting from the World Food Conference of 1974. These shifts which could simply be shown embedded in the definition of food security itself are "from the global and the national to the household and the individual: from a food first perspective to a livelihood perspective and from objective indicator to subjective perception."

2.2 Definition of Food Security and Conceptual Perspective

Emphasizing the multi-dimensional and complicated nature of food security FAO (2003:3) explained it as "Food security is a multi-faceted concept variously defined and interpreted. At one end of the spectrum food security implies the availability of adequate supplies at a global and national level; at the other end, the concern is with adequate nutrition and well-being." Edward

(2006) also stated that significant transformations are seen in the conceptual lifetime of food security due to the dynamic nature of the concept.

To start with the earlier ones, food security is defined for the first time as "availability at all times of adequate world supplies of basic food stuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN 1975). While in the 1980's it is defined as "access by all people to enough food for an active healthy life" (WB 1986:1, Sen 1981). FAO (1996) defines food security as "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."

In this paper the working definition of food security is taken to be the FAO (1996) food security definition: "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" Based on this definition, the following dimensions of food security are considered to be the main components. These are food availability dimension, food accessibility dimension and nutritional or dietary dimension. Besides according to Maxwell and Smith (1992) security and time are concepts found in the inherent definition of food security.

2.2.1 Food Accessibility

What comes at the forefront for the emphasis given to the concept of access in the 1980's food security definition and literatures is Sen's (1981) entitlement approach which states that "Starvation is the characteristic of some people not having enough food to eat. It is not the characteristic of there being not enough food to eat". Access to food is determined by entitlements to food. Stocks of assets, physical and human capital, common property resources access, and variety of state, community and household level contracts are routes to entitlements. FAO (1996) also puts "the physical and economic access to sufficient food "as the basic point of the food security definition. According to S.Maxwell (1996) food production is considered as a means to entitlement (access), either just to the producers or by reducing food prices to consumers.

In this paper view, access[2] is taken as synonym with household's endowment and capacity to produce and buy. Access is a key in determining the individual status to be food secure or insecure.

[2] Note: Access is taken to be one and the same with household's endowment and entitlement.

Hence individual household access, as given emphasis in the 1980's in a transition from global and national supply concern to individual household entitlement, is the important point in food security defnition.

2.2.2. Food Availability

Food availability can be seen as a physical availability of food and it is direct result of individual access to resources. What is accessed by the house hold whether by production, purchase or some other means can be seen as what is available. Food availability combined with food access leads to food security at the individual household level. According to FAO (2013) food availability is a dimension of food security that plays a prominent role. Enough supply[3] (availability) of food to a population is a necessary but not sufficient condition for food access. This is really the case when we see the national food supply or availability could not guarantees the individual household to access that supply unless and otherwise that specific household has the means, the resources and the purchasing power to access that supply. Thus this rests on the statement that a household access to resources leads to that specific household food availability or supply by enabling that household to be able to produce his own food or to buy and use his food requirement.

2.2.3. Food Utilization/Nutritional or Dietary Content of the Food and Absorption of the Body Dimension

According to S.Maxwell (1996) in the third shift in the food security definition a transition from the objective measure to subjective measure is seen. In this stage it is introduced that, it is not only the amount of food availability or adequacy that matter for food security, the quality of food also matters. For example, the conventional method of food security measure which is usually proxied by the amount of food intake or consumption in calorie is an objective measure which captures only the adequacy of food which may keep the body alive. This by itself has some problem as it does not involve the nutritional dimension of the body requirement. And this nutritional requirement is a value judgment. Besides, S.Maxwell (1996:159) goes beyond food security to nutritional status putting that "household food security should be considered a necessary but not a sufficient condition for adequate nutrition.

2.2.4 Security and Time

Other key concepts in the concept of the food security definition according to Maxwell and Smith (1992), is the terms security and time. Security reflects how much the house hold is free from

[3] Supply is taken to be synonym with availability.

vulnerability or risks to entitlement failure. They elaborated the concept as "the most food insecure households will be those facing the greatest probability of an entitlement failure." Related concept to vulnerability is time. The time dimension of the food security problem emphasizes the concept of risk. Hence food insecurity can be chronic in which the household faces continual risk of food insecurity and transitory: a situation by which the household faces temporary failure in entitlements. As the measure of food security in this study is average calorie intake, these aspects are not considered.

2.2.5. Interrelationships of Food Security, Availability, Access and Utilization

Renzaho and Mellor (2010) present the relationships, interactions and interconnections between food security, food availability, access and utilization in figure 2 below. As described in the figure, food availability, food access and food utilization combined affect food security status. Food availability and food accesses themselves are influenced by various internal and external factors. These factors are the determinants of the household's access to resources, volume of production and storage. Absorption capacity of the body which can be manifested through the demand for verities, dietary composition and health aspects has significant impact on the level and ability of the body to utilize a given food. These three factors altogether affect food security status.

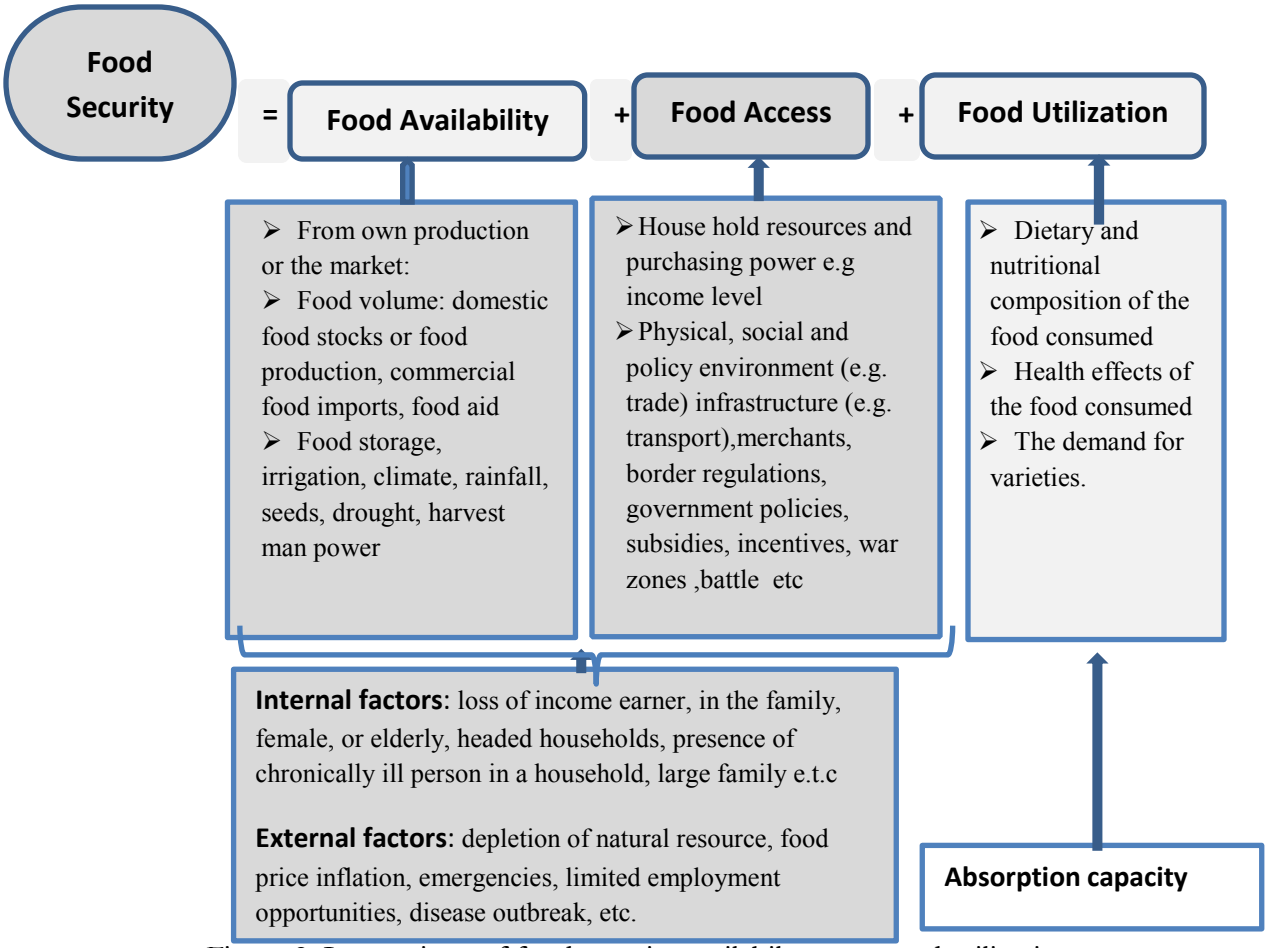


Figure 2. Interactions of food security,availabilty,access and utilization

Source: Renzaho and Mellor (2010), modified

2.3. Pathways to Nutritional Status

Implicit in the notion behind food security definition as "secure access to enough food all the time" is "sufficiency of food defined mainly as the calories needed for an active healthy life." When most of the food security literature refers to "food", the main focus is "calories and not with, micro nutrients and protein." The main justification behind is analysts perceive when calorie intake is satisfied, other needs are usually satisfied. Besides, as food is central to both food security and nutrition there is an overlap between the two (Maxwell and Smith1992). What is deduced from this explanation is that households with sufficient calorie intake are food secured and at the same time have good nutritional status. But can one be guaranteed that if calorie intake is satisfied then quality[4] of food (proportion of nutrients) is also satisfied?

[4] Note : quality of food is considered to be the contents and proportions of nutrients and micronutrients in a given food.

As described by S.Maxwell (1996) in the third stages of the food security definition, it is not only the adequacy of food that matter the quality of food also matters. Maxwell and Smith (1992) also pointed out the prevalence of parallel literatures that indicated that "food security is a necessary but not sufficient condition for adequate nutrition. The presence of additional condition, including "care and health" and "genetical and hereditary" factors matter in order for a household to be in an adequate nutrition. Based on FAO (2013), a household is said to be nutritionally secure when a household attains secure access to food coupled with a sanitary environment.

Accordingly in the third stage and recent definitions of the concepts adequate nutrition and food security, nutritional security is food security plus some additional factors like care and health and genetical factors. Food security itself is sufficiency of calorie intake plus quality of the food in terms of proportion of nutritional. But in the earliest stages of the development of these concepts, according to Maxwell and Smith (1992), food security seems to equate with sufficient calorie intake as it is inferred that when calorie intake is satisfied, other needs are usually satisfied. Quality of food was not given much focus in this stage. Then by inference nutritional security is sufficient calorie intake (food security) and some care and health aspects.

Figure 3 below, adapted from Acosta and Fanzo (2012) depicts, an analytical framework describing pathways to nutritional status. This framework is synonym with S.Maxwell's (1996) statements that says it is not only the quantity of food that mattes to food security the quality of food matters as well. This figure specifically describes how basic determinants, underlying determinants and immediate determinates influence the nutritional outcome. Besides, this framework emphasizes how food security, quality of care and healthy environment combined determines the dietary intake and health status levels. Dietary intake and health status levels then explain the nutritional status. Food security, quality of care and health services themselves are determined by resources to food security, care giver resources and health resources which are in fact determined by the potential resources, economic structure political and institutional structures. Additionally this analytical framework reinforces FAO (2013) and Maxwell and Smith(1992) definitions that nutritional security depends not only on food security but also health aspects.

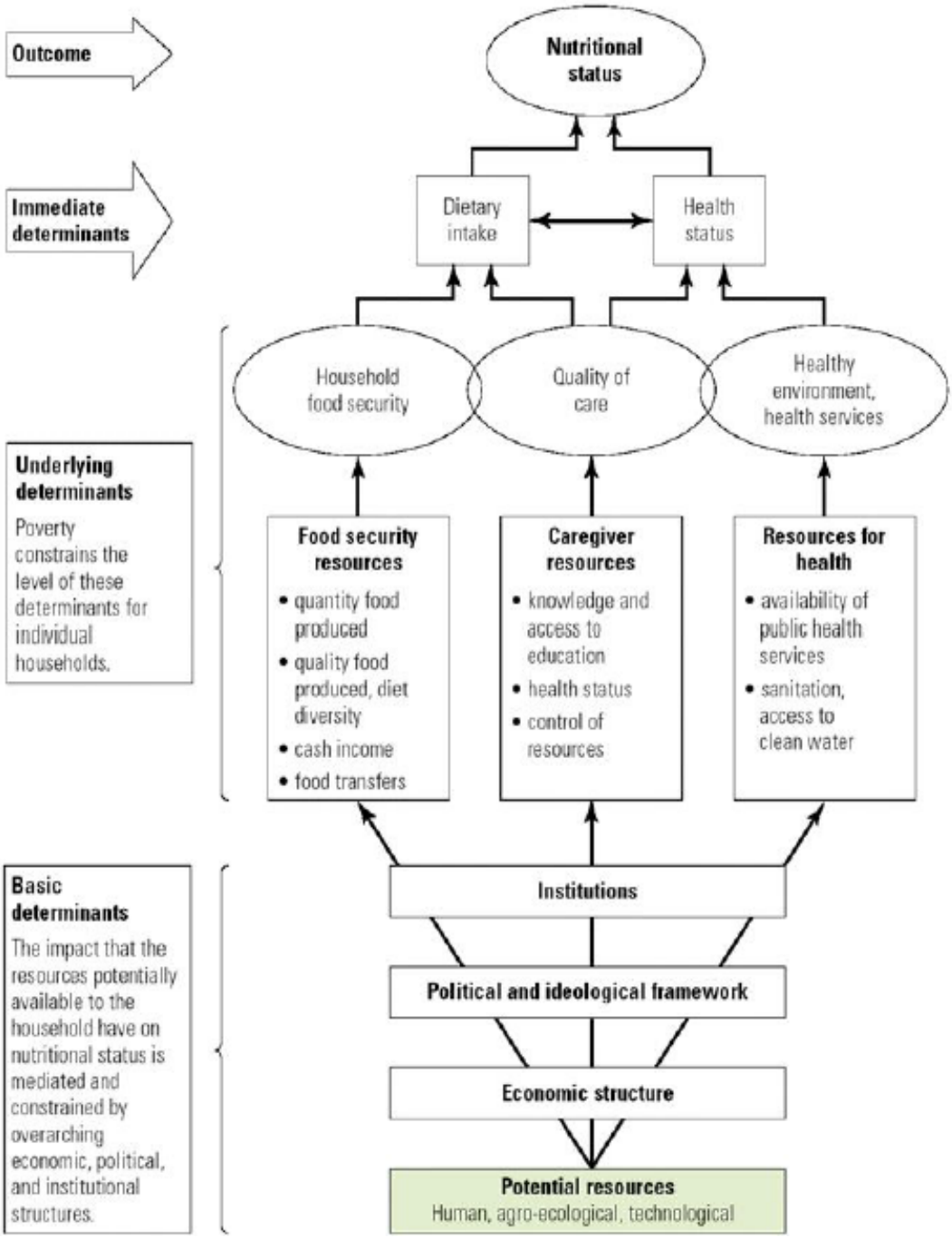


Figure 3. Pathways of nutritional status

Source: Acosta and Fanzo (2012)

The target behind the explanation in 2.3 is that, the third move which suggests food security concept to consider well the quality of food and not only the calorie sufficiency is warmly accepted. Nutritional security is then food security and the fulfillment of quality of care and health services. However since we are lacking the data on the proportions of micronutrients of the food

consumed and also on the quality of care, sanitation and the genetical factors, the quality of nutrition and other aspects are not dealt in this study. This study looks at nutritional status of a household only on the context of sufficiency of calorie intake. Thus, we can argue that both the food security as measured by sufficiency of calorie intake and measure of nutritional value again measured by the calorie sufficiency seem to overlap. In this context, thus we can say that, what determine food security determines nutritional status or sufficiency of calorie intake. This way of analyzing nutritional status seems to match with conventional (earlier) method which relies on energy sufficiency of food intake.

On the basis of this, factors affecting both food security and nutritional status are taken to be one and the same and are analyzed subsequently. In relation to this, the econometric model, fixed /random effects model which is best explained in the methodology section is used to analyze the determinants of sufficiency of calorie intake or nutritional status.

In this study the two terms, sufficiency of calorie intake[5] and nutritional status are used interchangeably. The logic behind is that, the literatures indicated as calorie intake is satisfied or sufficient then the nutritional value is also satisfied. By the same taken if there is sufficient calorie intake as given by the minimum level of calorie then there is food security. Note that food security is also measured in terms of levels of per capita calorie intake. The following section presents this.

2.4. Measurement and Determinants of Food Security

2.4.1 Measuring Food Security /Calorie Intake

According to D.Maxwell (1996:291) complete analysis of food security is challenged by the existence of situations in which there are variable household compositions, harvests of subsistence production are piecemeal and are neither measured nor recorded and differing income sources which the house hold member do not want to disclose. Hence measuring food security in a valid reliable and cost effective manner has been a problem faced by researchers. Besides, question of access to food is addressed through household, as the household is a sound logical social unit. This requires consumption and needs of the household and dynamics of the intra household resource allocation that affect distribution and procurement of food.

In relation to that, there are two most commonly used ways of measuring food consumption that analysis of most paper based up on. These are the expenditure method and the

[5] Note : The terms sufficiency of calorie intake and nutritional status are used interchangeably.

intake method (Bouis as cited in D.Maxwell 1996). Elaborating this expenditure and intake methods further D.Maxwell (1996) renamed them as disappearance method and 24 hours recall method respectively. Following D.Maxwell (1996), the current study bases the measurement of food security on the disappearance methods. This method is mainly used to compute calorie intake. The computed calorie intake is then used to determine the food security status or sufficiency of calorie intake of a household. The following section presents the detail.

2.4.1.1 The Disappearance Method: Computing per Capita per Day Calorie Consumption

The disappearance method: estimates the household food consumption as the difference between what comes to and out of the household door. A net change in stock holding is added to it or subtracted from it to arrive at what is consumed by the household. In a more detailed manner it is restated as, initial stock holding in a given period, if any, is added to food accessed through production, purchase, loan and gift to arrive at food available. Then food that comes out of the household door through sale, loan repayment and gift to relatives is deducted from the total available food to give a remaining stock of food by the household. This remaining stock of food by the house hold is then compared with the actual ending stock holding of by the household, if any, to arrive finally at the food consumed by the household. **A 24 hour's recalls method**: this method measures a 24 hours recalls of the consumed food by each member of a house hold then the caloric content level is analyzed out of the food consumed.

Haile et.al (2005) uses the disappearance method in Koro Degaga district, of Ethiopia to determine the calorie consumption at a house hold level. Accordingly, caloric availability from cereal is calculated for a given household by accounting own production and net transaction in a given period. What comes to and out of the household door is accounted to arrive at the disappearance. Then what is disappeared is converted in to total calorie consumption by a conversion unit.

Both of the above methods have their own merits and demerits. Mostly the disappearance method is used by the economists while the 24 hours recalls method is used by the nutritionists. Alternative food security measurement strategies like coping strategies, coping strategies index, marketing and rain fall data and food balance sheet method are some among the many. Each method has its own advantage and limitations. Cumulative coping strategies index for example captures the food sufficiency and the vulnerability element of food security. And it has some good

potential which others do not have. But at the same time assigning values to and interpreting the concepts like "frequently" and "rarely" has been problem. Besides short term coping strategies index being a reflection of the current food security status, cannot serve for predicting the future food security status (D.Maxwell 1996). Finally, Maxwell et.al (2008: 534) stated the search for more broadly applicable measures of food security continues, although some progress has already been made.

FAO (2013) stated that dietary or calorie intake is one measure of food security that captures availability and access dimension. Therefore, taking in to consideration all these points in relation to the available data source, the study opts to use the disappearance methods as a means to compute the per capita per day calorie consumption.

The disappearance method computation is carried out in stages. The first stage is conversion of different sources of grain in to equivalent calories by a given conversion rate so that the different types of grains are standardized in similar units of Kcal enabling additions and subtractions. In the second stage, grain that comes in and out to the house hold door is accounted. Any source of grain that comes to the house hold ownership are accounted as an addition to the initial grain stock holding, if any. Transactions that add to the initial stock holding are given (+) sign while those that deducts given a sign (-). Hence production (+), purchases (+), gift received in grains (+) and loan repayment received in grains (+) are added with the initial stock, to arrive at the overall available food calories with in a given period. Then from this available stock, the household sale (-), loan and gifts given to others (-) and remaining stock at hand (-) are deducted, to obtain the quantity in calories of food "disappeared"[6] in that given period of time. In the third stage the total caloric consumption obtained in stage two is converted to per capita per day caloric consumption based on a given household size and the number of days in a year. Fourth stage is comparison of the per capita per day calorie consumption with the standard requirement of 2200 kcal per capita per day calorie consumption which is set by (MoFED 2013). MoFED (2013) expresses the 2200 kcal food poverty line as an energy requirement that is only sufficient to an individual to walk and perform light tasks. Table1 and table 2 present the food and income poverty lines respectively.

[6] Note: the term disappeared is taken to be synonymous with consumed amount.

Table 1.Food and income poverty lines as used in Ethiopia

Description	Food and income poverty lines as used in Ethiopia
Kilocalorie per adult per day (Kcal)	2,200
Food poverty line per adult person per year (Birr)[7]	648
Total poverty line per adult person per year (Birr)	1,075

Source: MoFED (2013)

Table 2. Category of levels of food poverty

Level of poverty	Kcal per adult
Extreme poverty line	1650
Poverty line	2200
Moderate poverty line	2750

Source: MoFED (2013)

2.4.2 Determinants of Food Security

Different literatures use different proxies as a measure of food security and use different methodologies. On the grounds of that, these literatures find out various factors as determinants of food security. Some literatures show conflicting results for the same factor even if the majority seemed the same. Some of them are presented below and are used later on to compare with the current study results. Why these conflicting results happening, may be an area of research.

For example, Greenwell and Pius (2012) in their study in Malwi, used reported food security status, a continuous dietary diversity index and food end time as measure of food security. Logistic, ordinary least square, and quintile regressions were used as an estimation method. This study found that house hold food security is determined by credit access, age, sex of the household head, extension information, assets or wealth and education. In this literature age is found to have negative association with the food security status. The justification given is that even if young farmers tend to be less experienced, yet they are more food secure due to their dynamic and energetic nature. A study in Pakistan by Asghar and Muhammad (2013) found that household size, household income, irrigation facility, and age determine food security. In contrast to the results by Greenwell and Pius (2012), Asghar and Muhammad (2013) found that age has a

[7] Note :Birr is the Ethiopian local currency usually denoted as ETB

positive impact on household food security and justified that experience has more weight for a household status to be in food security.

According to a study in Bangladesh by Majumder et.al (2012) profession and crop cultivated, farm size and professional support found to be significant determinant of the household food security. In this study, it seems that variables like age and other household characteristics are not controlled.

2.4.2.1 Determinants of Food Security in Ethiopia

In Ethiopia context, studies on food security in different parts of Ethiopia including SNNPR, Oromia, Somali and Amhara regions are reviewed. All these regional studies are conducted using cross-sectional data. Despite these works are carried out in different regions, we may need to know, if the determinants found to be similar or different.

On a study on the southern part, by Feleke et al. (2003), technology adoption, farming system, farm size, land quality, household size, off farm income and wealth are considered to be determinants of food security and all except wealth and off farm income are found to be significantly determining food security. This study basically categorized the determinants in to supply and demand side factors. The factors which were said to be demand side are household size, per capita aggregate production and access to market. The result pointed out that supply side factors which include technological adoption, farming system, farm size and land quality, are more powerful than the demand size factors in determining food security status of the farm household in the Southern Ethiopia. What is lacking in this study is, rainfall shock which is usually thought to have significant impact on food security in Ethiopian context is not controlled.

Unlike the study by Feleke et al. (2003), Demeke (2011) assessed the impacts of rainfall shock in the farm household food security in Ethiopia and found out that rain fall shock significantly affects food security. Even if this work is on impacts of rain fall shock, other factors which were justified to have impact on food security of a household are controlled.

A study by Haile et.al.(2005) at Korodegaga, a peasant association found in Oromia region of Ethiopia, used cross sectional data and a binary logistic regression as the econometric model. The study controlled for many factors which meant to have an impact on food security status of a given household in the district. Out of eleven factors that were fitted to the model, farmland size, oxen ownership, fertilizer application education of the household head, and household size found

to be significant determinant of household food security. This study again did not take in to account rain fall shock.

Similarly, a study at Ada Berga, a district in the central Ethiopia, Beyene and Muche (2010) found that off farm income, livestock and land holdings, agricultural practices and farming activities significantly affect household food security. Chemical fertilizer use also affects food security positively. In a study at Jiggiga district of Ethiopia, that uses an empirical analysis by a logit model, Hussien and Janekarnkij (2013) find out that fertilizer use, credit access, extension service, and household income has positive influence on food security.

Generally complex sets of variables such as size of land, quality of available land educational level of the farm owner, quality and quantity of technology and capital available are important factors in influencing the level of food production (Foster 1992). Thus controlling for all these complex sets of variables is useful to obtain an unbiased estimate of these variables and their corresponding impacts on food security.

Chapter 3: Research Methodology

3.1. Empirical Strategy, Model Selection and Specification

3.1.1 Empirical Strategy

The paper mainly targets to look at the determinants of food security and sufficiency of calorie intake as a sub component. To these end three econometric models, the conditional logit model, fixed /random effects model and ordered probit models are employed. Conditional logit and fixed/random effects models have similar features of capturing panel data. Some authors like Chamberlin (1979) call the conditional logit model as fixed effect logit model, as both models have the characteristics of controlling unobserved heterogeneity. Ordered probit model has no room to capture the panel data nature. Thus, the study basically relies on conditional logit and fixed effects model to refer to the significant determinant variables.

The conditional logit and the orderd probit models are employed to identify and analyze the food security determinants whereas the fixed /random effects model is used to analyze determinants of sufficiency of calorie intake. As the dependent variable for all the three models is computed from the same per capita calorie intake(the computation of which is shown in the disappearance method section), it is true that the results of the fixed/random effect model and the ordered probit model reinforce the results of the conditional logit model in a way that the coefficients of the variables of the conditional logit and order probit models are similar in sign with the fixed/random effects model coefficients even if the magnitude differs. A description of each model follows next to this.

3.1.2 Conditional Logit Model Response Variable, Model Selection Rationale and Specification

3.1.2.1 Response Variable

This model uses binary choice food security status as its dependent variable. The food security status is computed from per capita per day calorie intake. FAO (2013) stated that one among the many food security indicators which captures the availability and access dimension of food security is average dietary energy supply adequacy[8]. The average dietary energy supply adequacy captures both the availability and the physical and economic access dimension of food security. Thus, as the food security status is computed from this dietary energy supply, it also captures the

[8] Note: average dietary energy supply is taken to be synonym with average per capita calorie (energy) supply.

availability and access dimension of food security. Similarly, Beyene and Muche's (2010) study at Ada Berga district of central Ethiopia, used household calorie acquisition to measure the food security status of the farm household.

The computation of the response variable, food security, is carried out by comparing the actual per capita caloric consumption per person per day with a standard per person per day required caloric intake threshold. If the actual per capita per day caloric consumption is lower than the standard average threshold 2200 kcal as given by MoFED (2013), it is given a value "0" which represents, in this paper case, food insecurity. Whereas, if the actual consumption is above the standard average threshold it is given a value "1" in our case food secured. The detail is described as follows:

Let the actual per capita per day calorie consumption is denoted as A_{PCPDCC}. We have also the standard requirement of per capita per day calorie intake denoted as S_{PCPDCC}.

If $\boldsymbol{A_{PCPDCC} < S_{PCPDCC}}$ **, then "*y*"=0,the house hold is " food insecure"**

If $\boldsymbol{A_{PCPDCC} > S_{PCPDCC}}$**, then "*y*"= 1,the household is " food secure"**

Where "y" stands for the dependent variable food security.

3.1.2.2 Rationale for the Conditional Logit Model Selection

According to Chamberlin (1979), this model is appropriate for a panel data discrete choice binary dependent variable. In a two year (t=2) panel data model which uses a discrete binary dependent variable for example, the issue of concern is the possibility that we may have $y_{i1}+y_{i2}=1$. Since $y_{i1}+y_{i2}=0$ or $y_{i1}+y_{i2}=2$ are already determined, the only concern of interest is the case that $y_{i1}+y_{i2}=1$. Hence $y_{i1}+y_{i2}=1$if $\boldsymbol{(y_{i1},y_{i2})}$ = **(0,1) or** $\boldsymbol{(y_{i1},y_{i2})}$ **=(1,0).** Conditional logit model captures this aspect of the panel data.

In our case a house hold food security status may be "1" indicating the house hold is food secure in both years 2004 and 2009 resulting in $y_{i1}+y_{i2}=2$ (note we are using two years panel data).The opposite may also holds true that food security may be"0" representing the household is food insecure in both years and thus $y_{i1}+y_{i2}=0$. The other situation is when the household is food secure"1" in any of the two years and food insecure"0" in the other year resulting $y_{i1}+y_{i2}=1$. This model captures this characteristic of the panel data.

3.1.2.3. Model Specification

In a conditional logit model, we have a binary dependent variable y_{it} and a latent variable y_{it}^* which is continuous. The model described as:

$$y_{it} = \beta x_{it} + \alpha_i + u_{it} \text{ .... (1)}$$

$$y_{it}^* = \beta x_{it} + \alpha_i + u_{it} \text{ .... (2)}$$

$$y_{it} = 1, \text{if } y_{it}^* > 0, otherwise, y_{it} = 0 \text{ ... ... (3)}$$

The respective probability, in a two year panel data model is as follows:

$$p_{r(w1=1/yi1+yi2=1)=pr(wi=1)/(pr(w1=0)+pr(w1=1))} = \frac{1}{1+exp^{(xi2-xi1)\beta}},$$ where:

- $w1$ is the sum of the values of $yi1 + yi2$
- y_{it} is the response variable for household, i, at time, t. It is the per capita per day caloric consumption.
- y_{it}^* is a latent variable which is unobserved
- X_{it} is a vector of independent variables for household i at time t.
- β is a vector of parameters
- α_i represents unobserved *woreda* specific effects which are assumed to be fixed over time and vary across *woreda*, i .
- u_{it} is the error term.

The effects of the vectors of regressors on food security are given by the sign and magnitude of β .

3.1.3 Random /Fixed Effects Model Response Variable, Model Selection Rationale and Specification

3.1.3.1 Response Variable

A continuous measure per capita per day caloric consumption is the response variable. The formulation of per capita per day caloric consumption is shown clearly in the disappearance method section.

3.1.3.2 Rationale for Random /Fixed Effects Model Selection

The random/fixed effects model is suitable for estimating dependent variable in a panel data having a continuous nature ruling out unobserved heterogeneity (Wooldridge 2012). England et.al

(1988) also stated about the quality of this model in removing unmeasured individual and time effects. In our case *woreda* (district) heterogeneity is assumed to exist and this calls for the use of fixed effects.

In the fixed effect (FE) approach the correlation between unobserved fixed effect αi and the observed explanatory variables (X_{it}) assumed to exist and αi is treated as non-random. Statistically it is represented as: $Cov(\alpha_i, X_{it}) \neq 0$. Where as in the random effect (RE) approach the unobserved fixed effect αi and the explanatory variables (X_{it}) are taken to be uncorrelated described as $Cov(\alpha_i, X_{it}) = 0$. Besides in the RE the αi is in the error term (Wooldridge 2012).

Using this model the study estimates the determinants of the per capita per day calorie intake. Albeit different interpretation the coefficient estimate of this model reinforces the result of the conditional logit model for food security.

3.1.3.3 Hausman Tests for Model Specification

Hausman test of validity is employed to test whether there is correlation between αi and the observed explanatory variables. Based on this the appropriate model for the case at hand (whether random or fixed effect model) is chosen. The null hypothesis is that error term u_i is correlated with the regressors. As the result signified, the chi square distribution is less than 0.05 suggesting that the null hypothesis is rejected and thus fixed effect should be used. In such cases random effect is in consistent. So we are using the fixed effects model as the basis of analysis and it is specified as follows.

3.1.3.4 Model Specification

The simple panel data model is represented as:

$$y_{it} = \beta x_{it} + \alpha_i + u_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (4)$$

Where:

- Y_{it} is the response variable for household, i, at time, t. It is the per capita per day caloric consumption.
- X_{it} is a vector of independent variables for household i at time t.
- β is a vector of parameters.
- α_i represents unobserved *woredas* specific effects which are assumed to be fixed over time and vary across *woreda*, i .

- u_{it} is the error term.

3.1.4 Ordered Probit Model Response Variable, Model Selection Rationale and Specification

3.1.4.1 Response Variable

Response variable in this model is categorical variable classified as food secure, moderately food secure, moderately food insecure and severely food insecure. Based on MoFED (2013) those calorie intake greater than or equal to 2750 Kcal are food secure and encoded a value"1". Calorie intake between 2750 Kcal and 2200 Kcal is taken to be moderately food secure an encoded a value"2". Moderately food insecure is encoded a value "3" for those calorie intake ranging from 2200 Kcal to 1650. Severely food secure is encoded with a value"4" for those calorie intake less than 1650 Kcal.

3.1.4.2 Model selection Rationale

Ordered probit is one among Maximum Likelihood Estimators (MLE) which is appropriate when we want to explain a variable in an ordered type of responses. This model is an extension of the binary probit model. Binary models usually through away information as it lump responses together (Wooldridge 2012). According to Kockelman and Kweon (2002) unlike multinomial probit ordered response has the advantage of keeping data's ordinality and does not require more parameters. This enables degrees of freedom not to be lost. In this paper our dependent variable, food security, is categorized in to four different categories or responses. So this enables to see the impacts of the explanatory variables in the ordered food security.

3.1.4.3 Model specification

There is a continuous latent variable underlying the response variable. Associating the latent, there is a normal distribution of the error term. Here is the model specification.

$y_i = k \text{ if } \mu_{k-1} < y_i^* \leq \mu_k + \ldots\ldots$ (1) Observed categorical outcome

$y_i^* = \beta x_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$(2) Unobserved ,latent variable

Where k= 0, 1, 2….K, and it is the ordered responses

μ's are the parameters

3.2 Possibility of Endogeneity and Simultaneity

Regressions in the presence of correlations between the error term ε_i and any of the regressors may result a biased estimate. The same holds true if there is reverse causality between the regressors and the dependent variable. In the food security literatures endogeneity is widely

recognized. For example a study in Malwi by Green well and Pius (2012) stated about the possible auto correlation between farm income and the error term in their regressions using any of food end time, dietary diversity and perception of food security as dependent variable. Thus, there exists the possibility of biased estimate if the autocorrelation between the error term and this regressor is not ruled out.

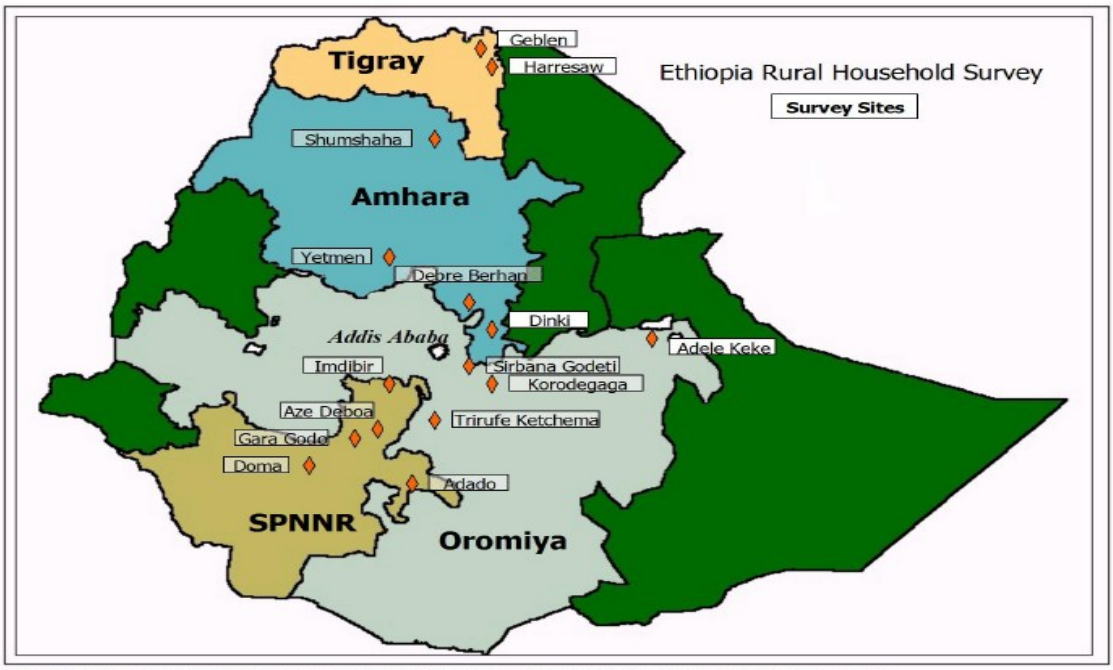
Demeke (2011) recognized the possible endogeneity between the regressors of farm income and credit access with the error term. In order to rule out the suspected correlation, this study used instrumental variable regression. In the current study, we suspect the same problem between of farm income and credit access, yet we hold the view that the panel data models, can rule out some of the problems even if, it may not avoid it completely. Thus, instrumental variable regression is not employed.

Chapter 4: Data, Variable Description and Descriptive Statistics

4.1 Data

The current study uses Ethiopian Rural Household Survey (ERHS), a unique longitudinal data, which the Economics Department of Addis Ababa University (Economics/AAU), International Food Policy Research Institute (IFPRI), University of Oxford and the Center for the Study of African Economies (CSAE) supervise. Financial support for the data collection is provided by the Economic and Social Research Council (ESRC), the United States Agency for International Development (USAID) and the Swedish international Development Agency (SIDA). The data is being collected from the rural Ethiopia starting from 1989. At that time the data collection started with seven peasant associations found in Amhara, Oromia and Southern Nations Nationalities and Peoples Region (SNNPR) with a total of 450 households. Gradually the data collection is expanded to cover fifteen villages including Tigray region. The expansion enables accounting for the diversities in the farming systems.

The latest seventh round survey was conducted in 2009. Aiming to achieve the benefit of relatively recent data, the current study uses the latest two rounds of survey data, the six rounds and the seventh round data, the 2004 and 2009 survey data respectively. Figure 3 shows data collection sites or Peasant Associations (PA) in the four regions.



Note: All borders and survey site locations are approximate. Source of basic map (country and regional borders) : UNDP-EUE. 1998. < http://www.sas.upenn.edu/African_Studies/eue_web/graphics/newzones.gif>. Updated February 15. (accessed May 16, 1999).
SPNNR is Southern Peoples Nations and Nationalities Region

Figure 4. Map of data collection sites[9]

4.2 Description of the Dependent Variable

The per capita per day calorie consumption is a dependent variable for the fixed effect model and a means to compute the dependent variables for the conditional logit and ordered probit models. Thus, in the process of computing the per capita per day calorie consumption all cereals and crops; produced, bought, sold, received and given in some ways are included. However a cash crop which is known as called "chat" in its local name and very well known for being a stimulant rather than being food is excluded as there is no set calorie conversion rate for it in our country context.

Transactions of another basic cash crop, coffee, such as production, sale, loan taken and gift received are included even if it is consumed in a very small proportion at household level. The rationale behind is that, what is included in the computation as a production nets out through sale. Any difference, if any, between production and sale is what is consumed by the household. Besides, there is a calorie conversion set for it. This suggests that there is some energy (calorie) which a household drives from consuming coffee. Appendix II presents the food conversion rates as used in Ethiopia.

[9] Source: taken from presentations of Abera Birhanu Demeke at the 11th seminar of EAAE 25-27 November 2010-Hohenheim,Germany.

4.3 Description of Explanatory Variables

Based on the review of the literatures and practical experiences, explanatory variables which have logical and justifiable rational in determining food security status of a rural farm household are identified. A description of those variables and the hypothesis of the effects of these variables on food security are presented in this section.

According to their nature, these variables are categorized under five categories. **Household characteristics** which include age, sex and educational level of the house hold head and family size. **Access to financial resource and social network** category includes credit access and off arm income. **Access to physical and natural resource** involves, oxen ownership, land quality and farmland size. **Technology adoption** involves the use of fertilizer and **natural and manmade socio environmental factor** involves rain fall shocks. Out of these priority variables and control variables are identified.

Variables that are considered to be the most limiting factors for the rural farm households are priority variables. These include farm land size, houshold size, fertilizer use, quality of land, rain fall shock, credit access, off farm income and oxen ownership. Control variables include household characteristics like education, age and sex of the household head. A detail description of each of the variable is made in the next session.

4.3.1 Description of Priority Variables

Farm land size

According to Foster (1992), in the world in general, poorest people are landless. The relation between food security and household production in a given land is mainly appropriate to farm households. Haile et.al (2005) also stated there is a positive and significant relationship between farm land size and food security. On the contrary, Altieri (2008:6-8) stated that there is inverse relationship between farm size and production indicating that as the farm land size is smaller the household tends to be more productive. This is due to the fact that the household invests more for land improvement. In the current study, farmland size is a continuous variable representing the size of the farm land in hectares that the household cultivates. Based on the above argument thus, it is expected that, there could be both positive and negative association between farm land size and food security.

Household size

According to Feleke et.al (2003) labor availability and pressure on consumption is best described by household size. Similarly, Asogwa and Umeh (2012) stated land holdings and finance are very limited for the small scale and subsistence farmer. Given this, adding more family creates more pressure on consumption than the labor it contributes. In the current study, household size is a continuous variable which best explains the number of family members living in a household. Thus we expect that as the number of family in the household increases food security decreases as there are much more family who are going to share from the given yield or income.

Fertilizer use

Haile et.al (2005) stated, fertilizer use is taken to be a proxy for technology in most literatures. How a given technology is being used is a key point in determining level of production and it is actually influenced by many government interventions, incentives and disincentives (Foster 1992). Calorie intake and food security are influenced by use of fertilizer as it boosts agricultural production (Rutsch as cited in Haile et.al 2005:5). Based on the questioner, fertilizer use is thus a dummy variable representing whether the household uses a fertilizer or not. Thus "1" represents if the household uses a fertilizer and '0" otherwise.

Quality of land

Sah (2002) stated that, better quality of land increases agricultural productivity even only with optimal management. Land quality is much more related with the farmland size. Based on the questioner, quality of land is given a dummy where "1" representing fertile and "0" for infertile. It is expected that quality of land to have a positive effect on food security.

Rain fall shock

Irregularities in weather have adverse consequences due to the rain fed nature of agriculture in Ethiopia (Demeke 2011). Similarly, in the current study, rain fall shock is taken to be a deviation from what it supposed to be. Thus it is actually considered bad and is a disaster for given harvest year. Accordingly, a dummy is created if the rain stops too late and too early. It is expected that rainfall shock to have a negative effect on food security.

Credit access

A dummy variable is created that represent the response "yes" with a value "1" for those households having an access to credit and "no' with "0' otherwise. Following Demeke (2011), it is expected that credit access to have a positive effect on food security.

Of farm income

A dummy variable whether the household head works of farm. According to the data this study uses, off farm income is a situation by which the household earns income through participating in an activity out of his own farm. This could be in food for work or in a farm other than own farm. Hence it is given a value "1" if the household works of farm and '0" otherwise. Holden et.al (2004) found that, off farm activity has positive welfare implications. Thus, it is expected that off farm income to have a positive effect on food security.

Number of oxen owned

A continuous variable which measures the number of oxen the household owns**.** It is expected that number of oxen owned to have a positive effect on food security. According to Govereh and Jayne (1999), oxen enable the farm household to cultivate greater farmlands. In Ethiopian context where mechanized farming is not that much developed due to economical reason and even due to the topography of the farm lands, oxen are the main household wealth that are used for ploughing and harvesting.

4.3.2 Description of Control variables

Education of the household head

According to the level of education of the household head, education is taken to be a categorical variable. A household head is categorized to be illiterate represented by a dummy variable with a value"1" if the head did not attend any schooling whether formal or informal. Dummy for primary education is created if the household head completed primary school. Secondary school dummy stands for the household head attending secondary education. Higher education dummy represents the household attending higher level education. And a dummy for informal education refers to education attended which is given by churches and mosques.

As the household head gets more and more educated he may not be resistant to new practices and technologies which may bring higher productivity and yield that has implication on food supply (Asogwa and Umeh 2012). Hence we expect that education and food security to be positively correlated. In the regression process the dummy for illiterate is taken to be a base (left out) category for referencing.

Age

Refers to the experiences the household obtains. As the household age gets higher and higher the more the stable the economy will be. This is due to the fact that older people have richer experiences. Besides older people have more access to land than younger people as young people have to wait for land redistribution or they have to share with families (Asghar and Muhammad 2013).

Sex

This is dummy variable where"1' represents the household head is male and "0" otherwise. Green well and Pius (2012) stated that gender in Africa is much more related to access to resources. In Africa context, most females are resource poor which may contribute female headed households to be in food insecurity status than male headed households. In addition male headed households may have capability to invest better effort on their farms leading to a better production. Thus it is expected that sex ("1") being for a male, has a positive association with food security.

Dummy year

Year variable is controlled to account for any unforeseen effect that can be attributed to special events affecting the response variable. This variable is considered in both the conditional logit model and the fixed effect model.

Generally based on the literature and experience, the factors which are fitted in the models of this paper are hypothesized to have negative and positive effects on household food security and sufficiency of calorie intake. Table 3 presents the summary of the hypothesis.

Table 3. A summary of expected sign of socioeconomic variables (determinant factors) on food security and calorie intake.

Description of the variables	Measurement	Expected sign on food security and calorie intake
Age of house hold head	Years	+
Sex of the household head	Dummy,1=male,0 = female	+
Education of the household head	Categorical, with a 0,1 dummy	+
Household size	Number of families in a house hold	_
Farm land size	Total area of land in hectares	+/-
Land quality	Dummy, 1= fertile,0= infertile	+
Fertilizer use	Dummy,1= if the hh[10] uses fertilizer,0,otherwise	+
Rainfall shock	Dummy,1= if the rain stops too late and too early,0, otherwise	_
Off farm income	Dummy,1= if the hh works offarm,0,othewise.	+
Credit access	Dummy,1= if the hh has access to credit,0,otherwise.	+
Number of oxen owned	Number	+

Source: own expectation

4.4 Descriptive Statstics

By tabulating the house hold unique identifier, household ID, it is confirmed that each house hold is uniquely identified. The data is a two year panel data with a total observation of 2214 for the two years. We have also checked that attrition at the household level is very low.

As shown in table 4, the majority (79%) of the households are found to be food insecure while the remaining 21% are food secured households. Food insecure household of 79% is really significant number. It indicates, in the survey years, that many of the households in the sample are prone to entitlement failure and calls for immediate intervention. This result is consistent with the

[10] hh refers to household.

findings by Haile et.al in a study at Oromia region of Ethiopia where food secure households are only 26% while the food insecure households amounts to 73%. This trend seems also more or less similar to other African countries. For example in a study by James et.al (2013) in Ghana, out of the total surveyed households 79% are found to be insecure and only the remaining 21% are food secured. So a collaborative effort is needed to through this challenge away from the root.

Table 4. Households's food security status

Food security status	Percentage
Food secure	21
Food insecure	79
Total	100

Source: own computation

The summary of the data in table 5 shows the average for the household entitlements to resources and other household characteristics. Thus the average size of land holdings in hectare is 0.86. This seems to hold true given the practical situations of small land holdings in our country context. Given the conversion unit of (1 hectare=4 timads[11]), 0.86 hectare actually approximates to 3.5 "timad". The average number of family size is 5.8. Whereas the average number of oxen owned is 0.76. Considering the importance of oxen for the rural farm household, this number is very minimal. Out of the total number of households in the sample, on average,39% uses fertilizer. Households having fertile land amounted to 38%. Both fertilizer users and fertile land holders are on the expected range. Yet, efforts must be there to increase this percentage a little more. Considering the educational level, 51% of the households are illiterate, 22% are having primary education and 7.9% have informal educations given by churches and mosques, the remaining is secondary and higher education attendees. It is not a surprise to find 51% of the household head illiterate when we consider the human development index level of the country. On average 49.9% of the households experienced rain fall shock. This is really a disastrous. Those households receiving off farm income are 41%. The average age of the household head is 47.The regional mean values are also presented in the Appendix III.

[11] Timad is a local unit of measure for farm land size. 1 timad is equivalent with ¼ of a hectare.

Table 5. Summary of mean of variables of all households

Variable	Mean	Standard deviation
Farm land size	0.863	0.829
Total number of oxen owned	0.761	1.083
Dummy credit	0.385	0.486
Dummy illiterate	0.513	0.499
Dummy primary education	0.224	0.417
Dummy informal education	0.079	0.269
Dummy fertilizer use	0.395	0.489
Dummy off farm income	0.417	0.493
Age	47.589	19.494
Household size	5.795	2.558
Dummy land quality	0.381	0.485
Dummy shock	0.499	0.500

Source: own computation

Chapter 5: Results and Discussion

5.1 Conditional Logit Model

As described in the methodology, this model is employed to analyze the determinants of food security for the rural farm household. Thus food security is taken to be the dependent variable and encoded "1" for those per capita calorie intake greater than the standard 2200 Kcal. Odds ratio is used to explain and interpret the partial effects of the variables. In the odds ratio, variables with a greater than one odds ratio are taken to have a positive association with the dependent variable while variables with a less than one odds ratio are considered to have negative association. On the basis of this, the determinants and their association to food security are identified.

5.1.1 Determinants of Food Security

Table 6 presents the odds ratio and the corresponding P values. A discussion of the significant priority variables is presented next to the table. Generally, among the variables that are fitted in to the model, eight of them significantly determine food security at varying levels of significance. Rain fall shock and household size were hypothesized to have deteriorating effect on food security with a negative association between them and food security. Both exhibited the expected sign and determine food security significantly. The rest six were assumed to have positive association with food security as there effect is to improve food security and found out to be positively correlated. Out of the eight significant variables five of them, farm land size, and land quality, credit access, rain fall and household size are among the priority variables, and a discussion of them follows.

Table 6. Odds ratio of variables, conditional logit

VARIABLES	Odds ratio	P value
Dummy shock	0.365**	0.050
Dummy land quality	3.043**	0.026
House hold size	0.516***	0.004
Age of household head	1.032***	0.002
Dummy off farm income	1.251	0.588
Dummy fertilizer use	2.129	0.288
Dummy informal education	1.219	0.760
Dummy higher education	7.005*	0.064
Dummy secondary edu edu	3.022	0.255
Dummy primary education	1.360	0.582
Dummy sex	3.215**	0.005
Dummy credit	17.008***	0.000
Total number of oxen	1.057	0.836
Farm land size	4.491***	0.000
Year 2009	1.105711	0.786

Source: own computation

Farm land size

The current study finds that, having an odds ratio of more than one, and after controlling for other effect, farm land size increases the odds of food security and it is significant at 1% level of significance. This definitely shows strong positive correlation between these two. This is consistent with the study by Haile (2005), Feleke (2003) and many other studies in Ethiopia that found out farm land size increases the likelihood of households being food secured. There are two questions to raise here. First; given this positive association that farm land size determines food security, what should be done to increase farm land sizes? Second; given our hypothesis (+/-) and the presence of literatures that pointed out cases by which the association between the two could be inverse, what policy should intervene to increase food security even with the existing small size of farm land holdings?

Regarding the first question and in reference to the findings of our result, policy should intervene in the following point. It seems first that; nothing can be made to increase farm land size in Ethiopia. Studies, however, show that there are still sites in Ethiopia where settlement is not yet densely populated. According to Derib(2014) while settlement in Harari and SNNPR region is most densely populated accounting to nineteen and thirteen times 15 persons/ km2 respectively, Gambela and Benishangul region settlement is widely dispersed in a less than average settlement, accounting to only one times 15 persons/ km2. So a strong policy intervention may be needed to relocate the population where settlement is densely populated to the sites where it is not. This enables, at least some group, to share from land holdings and any entitlements to resources which can lead to ensuring food security.

The second question can be addressed with policies that encourage maximum yield from a given holdings. As described in variable description section, there are studies that found negative association between farm land size and food security. For example a study by Altieri (2008) stated about the existence of inverse relationship between yield and farm size which is mainly due to the efficient utilization of a given farm land size in terms of biodiversity, water and other agricultural resources.

We can say that for the smaller land holder productivity to a given farm land and food security work only through land improvement which lead to better land quality. Tiffen et.al(1994) also stated that the presence of better investments in land improvement which lead to better

productivity and food security, if there is scarcity of land. The scarcity of land is mainly attributed to population pressure. Thus what we draw from this is that, small scale farmers, with only small size of farm sizes need to work efficiently in order to benefit the maximum yield out of it to ensure their food security. Generally, as entitlement for farm land is smaller and smaller due to population pressure, the people start to invest in land improvements and soil conservation which results in better yield and food security. In relation to this Appendix IV shows there are also some households in the current study who have less than the average household size yet they are food secured.

Land quality

In relation to land quality the current study finds that, after controlling for other variables, and with odds ratio of more than one, land quality increases the odds of food security and determine it significantly. This finding underlies in the justification given by Haile et.al(2005) that, even with optimal management, better land quality of a given land results in better productivity and increases the likelihood of a household to be food secure. With efforts in land improvement that can lead to better land quality the likelihood to food security can even be much better.

Rain fall shock

Rain fall shock decreases the odds of food security and significantly determines it at 5% of significance level. This is expressed in an odds ratio of less than one value. The rain fall shock is taken to be a situation by which the rain stops too late and too early. This is really a disaster and contributes negatively to food security. On one side a rain which stops too early is a shock as the crop may not complete the growth stage. On the other side rain which stops too late is also a disaster as the crop which is about to be harvested could not be harvested at the right time due to the rain.

Ethiopia is characterized by significant irrigation potential. Even if the irrigation potential is significant in the country only a less than1% cultivated land is irrigated (Yesuf et.al 2008). Thus, strong institutional support must be there in terms of providing the irrigation scheme technologies. In such a way, rain fall shock which may specifically emanate from early interruption of rainfall could be substituted with irrigation scheme so that growth stages of the crops continue to the harvesting stage.

Besides, Yesuf et.al (2008) analyzed factors affecting adoption of climatic change adaption strategies. The adaption strategies are in fact affected by factors like timely provision of future climatic information to farmers, mixture of formal and informal institutional support and the household characteristics itself. What lesson can we learn from this?

Rain fall shock caused by rain fall that stops too late can be tolerated by climatic adaption strategies like timely provision of rain fall data. In response to this strategy farmers can use seeds that are resistant to long rain fall season and uses too much water. Rise can be taken as one example that is cultivated in a watery land in Amhara Region. There is also a possibility of delaying the cultivation season so that it matches to the rain fall season. In relation to this, Deressa et.al (2009) stated that selecting appropriate crop varieties, late and early planting are some among the many climatic adaption strategies in the Nile Basin of Ethiopia. Generally strong policy intervention must be there to provide updated timely and long term rain fall data. Farmer's attitudes towards adoption strategies must also be guided by policy interventions.

Summary of the discussions under farm size, land quality and rain fall shock

As a summary of what we have discussed under the sections of farm land size land quality and rain fall shock above, FAO (2007) stated that every farmer's[12] wellbeing is a starting point for use of land resources and agricultural based ecosystems. Even if wellbeing of the farmers is the driving force for decisions on how to use the inherent land resources, development, economic, environmental and agricultural policies influence farmer's decisions on how and what to produce. These policies are the "externalities" to the farmers and include factors like, fertilizer, labor, land, pesticides, irrigation facilities and infrastructures etc. However, environmental friendly practices, that produces better yields may not be adopted either because it involves high opportunity cost and reduces farmer's net benefit or farmers have other barriers like lack of information. Therefore, It is logical to believe that farmers choses a combination of agricultural practices that maximize their wellbeing with the available opportunities and resources. Figure 5 below presents this trade off. Especially at the introduction of new practices an increased cost and even decrease yield can exist. In the contrary farmers may lose worthwhile practices either because they have lack of information or financial and leadership capacity needed for investing in new practices. Thus policy intervention should focus on practices that maximize the net benefit to farmers.

[12] FAO 2007 considered the farmers as the managers in their farmlands.

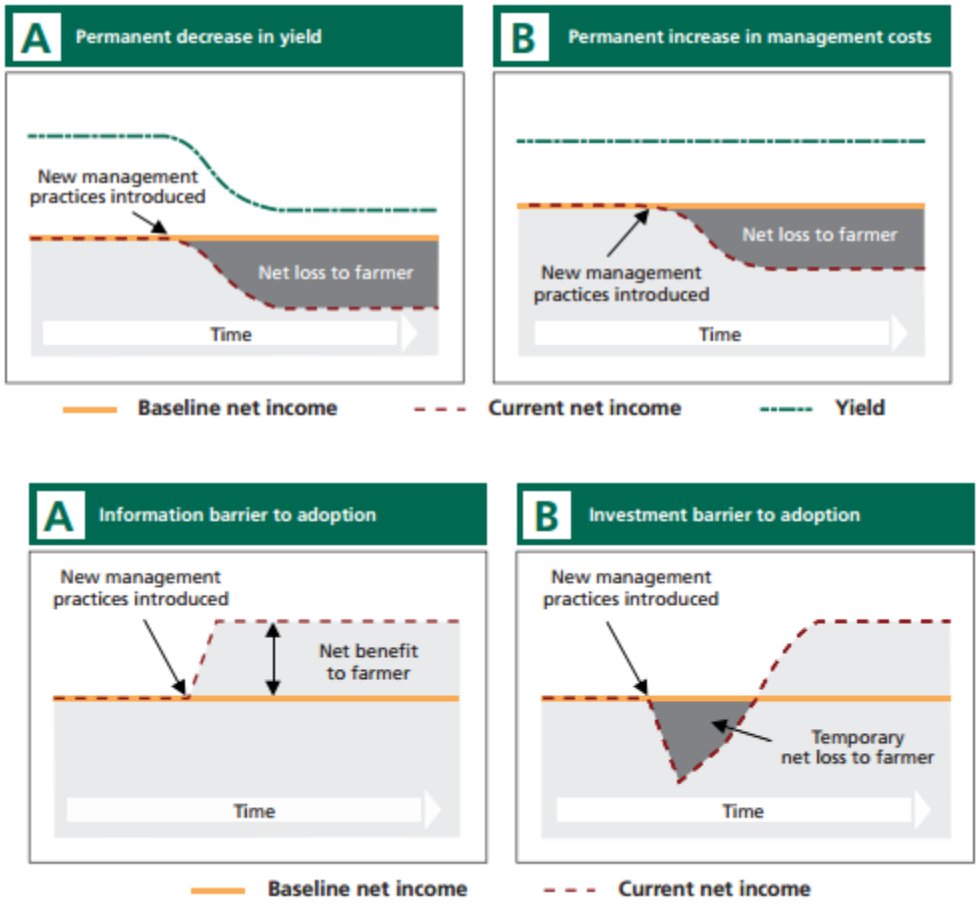


Figure 5. Adoption barriers to improved management practices

Source: FAO(2007)

Household size

Similarly household size decreases the odds of food security and significantly determines it. This is explained in the negative correlation that, as household size increases food security decreases. This is due to the fact that greater number of family tends to share from an existing production and yield. This suggests that there is a pressure in terms of resource allocation from a given entitlement in this area. FAO (2012) pointed out that food security is challenged by repaid population growth in Ethiopia. Most importantly, PRB (2013) indicated population of Ethiopian approximated 89.2 million in mid-2013. This shows a tremendous increase each year. And out of that 85% of the population lives in the rural area. Thus this growing number of population and household size is a disaster for the household food security. Taking in to consideration all these points, it is not a surprise to find the inverse relationship between food security and household size result. The

question to be addressed should be what needs to be done? What is feasible to consider in the context of Ethiopia in order to reduce food insecurity caused by increased family size?

Income diversification, labor sharing and family planning schemes may be considered as options in the rural farm household. However, Feleke (2005) stated increasing one more family member creates more challenge than the labor it contributes. Note that, we are interpreting the partial effects of an increased family keeping other things remain constant. So we are reserved to make Feleke's (2005) claim, where many of agricultural activities are done with human labor and off farm income is insignificant in this model. Those families might not have diversified their income enough to sustain that much family. Besides that family might be insecure as long as it has too many dependents. So, all we can suggest is interventions on labor sharing and income diversification can benefit a lot.

Credit access

Similarly access to credit, has likelihood of increasing food security. This is manifested by an odds ratio of more than one in the conditional logit model. This result is consistent with findings by Demeke(2011). While the result is rewarding, in Ethiopian context informal credit tends to be expensive and scarce. Banking institutions, formal credit lending and saving institutions are rare and even nonexistent in the rural areas. Even if microfinances are created around end of nineteen century, they account only 31 in 2012 reaching only two million people. Thus lack of credit access worsened food insecurity as they have no means to increase their income (Cordaid,n.d.). Thus, once we knew that credit access improves food security, at least for those who accessed it, outreaching the scope of microfinances and local saving mechanisms to rural farm household's should be put in policy interventions.

5.1.2 Examining Household Food Security Characteristics

As shown in table 7 below food security status has increased from 18.97% to 23.49% as we move from year 2004 to year 2009, even if the improvement is not significant. This is consistent with the odds ratio for the dummy year 2009 having a more than one value in the conditional logit model suggesting that there is a positive association between food security and an additional year. Unforeseen measures and efforts, like fertilize use, improved seeds and assistance from productive safety net program, which have been adapted overtime in the country, might have contributed positively to this end.

Table 7. House hold food security status overtime

Food security status	Percentage	
	Year 2004	Year 2009
Food secure	18.97	23.49
Food insecure	81.03	76.51
Total	100	100

Source: own computation

Table 8 shows that the food secure households have greater potential and entitlements to resources. For example a mean size of agricultural farmland is 1.637845 hectares for food secure households where as it is only 0.6542848 for the food insecure households. This is indicative for the result we got in the odds ratio above that, keeping other things constant, on average households with greater farm sizes are food secured than with smaller farm sizes. Similarly, 62% of food secure households are male while only 30% are in the food insecure household. This is also consistent with both our hypothesis and the odds ratio. Among the food secure households on average only 36% are exposed to rain fall shock and 54 % of the food insecure households were facing rain fall shock. Note that it was 49% for all households taken together. Thus it is not a surprise to find only 36% of the food secure households experiencing shock.

Table 8. Summary of mean of variables by food security status

Variable	Mean food secure household	Mean food insecure household
Farm land size	1.637	0.654
Total number of oxen owned	1.010	0.693
Dummy credit	0.551	0.340
Sex	0.621	0.300
Dummy illiterate	0.557	0.501
Dummy primary education	0.153	0.244
Dummy informal education	0.176	0.052
Dummy fertilizer use	0.700	0.313
Dummy of farm income	0.595	0.369
Age	49.465	47.083
Household size	4.044	6.267
Dummy land quality	0.636	0.312
Dummy shock	0.359	0.537

Source: own computation

In regional context, as shown in table 9 below, the biggest average farm land size for food secure households is in Oromia region followed by Amhara and SNNPR, the lowest being in Tigray region. The mean value of households experiencing rain fall shock is also the highest in Tigray region, being almost similar for the remaining three regions. In terms of land quality the SNNPR is the region with the most fertile land followed by the Oromia and Amhara region. Tigray region again possesses the lowest quality of land even for those food secure households. Considering these all factors we can conclude that the farm households in the Tigray region was only marginally secure in the given study period, 2004 and 2009. Specifically the rain fall shock and land infertility seem the highest there. So any policy intervention on irrigation scheme, climatic adaption strategy and land improvements should start from there.

Table 9. Summary of mean of variables for food secure households by region

	Food Secure Households			
Variable	Tigray	Amhara	Oromia	SNNPR
Farm land size	1.201	1.634	1.849	1.300
Total number of oxen owned	0.487	1.007	1.390	0.275
Dummy Credit	0.384	0.354	0.690	0.612
Sex	0.307	0.695	0.633	0.612
Dummy illiterate	0.641	0.531	0.490	0.737
Dummy primary education	0.076	0.134	0.161	0.2 00
Dummy informal education	0.051	0.319	0.157	0.037
Dummy fertilizer use	0.435	0.645	0.852	0.525
Dummyoffarm income	0.512	0.560	0.676	0.487
Age	49.717	51.546	46.657	53.050
Household size	2.923	3.765	4.904	2.825
Dummy land quality	0.205	0.609	0.661	0.825
Dummy shock	0.692	0.326	0.323	0.350

Source: own computation

5.2 Fixed Effect Model

This model uses per capita calorie intake as its dependent variable. The main objective of running this model is two folds. The first is comparing the results of this model with that of the conditional logit, which uses dummy food security computed from per capita calorie intake in 5.1 above. It is described and justified in chapter 2.3 that, in the context of the current paper, nutritional status is measured in terms of sufficiency of calorie intake. Thus in this context both

food security and nutritional status are measured in terms of sufficiency of calorie intake. In such a way, it is possible to compare the results of these two models. The second objective is, as the dependent variable for the fixed effect is calorie intake; we are using it to analyze the determinants of sufficiency of calorie intake/nutritional status. Note again that as nutritional status/sufficiency of calorie intake is measured in terms of per capita calorie intake as that of the food security, it is hypothesized that factors affecting food security (measured in terms of calorie intake) affects also sufficient level of calorie intake/nutritional status (measured in terms of calorie intake).

To account and control for, heterogeneity, the diversity in the agricultural ecosystems a fixed effect is regressed with clustering. The clustering is made at *Woreda* (district) level. Based on the findings, the results of the fixed effect reinforces the results of the conditional logit model in a way that the coefficients of the variables of fixed effect model is similar in sign with the conditional logit model even if it differs in magnitude and significance of the coefficient estimates. Thus, variables fitted in to this model except informal education and primary education significantly determines sufficient level of calorie intake/nutritional status at varying levels of significance. In terms of priority variables, farm land size, rain fall shock, credit access land quality, and household size determine nutritional status significantly. These sets of variables are the same sets of variables that are found to be significant in the conditional logit. Besides three more priority variables, oxen owned fertilizer use and off farm income significantly determine nutritional status. Table10 presents the coefficient estimate of fixed effects model. A discussion of these three remaining significant priority variables is presented next to the table.

5.2.1 Determinants of Sufficiency of Calorie Intake/Nutritional Status

Table10. Fixed effects model estimation results

VARIABLES	(1) Percap
Dummy rain fall shock	-137.5**
	(42.26)
Dummy land quality	185.0***
	(35.16)
House hold size	-134.9***
	(10.99)
Age of household head	8.208***
	(1.302)
Dummy off farm income	255.6***
	(47.32)
Dummy fertilizer use	384.8***
	(48.64)
Dummy informal education	111.3
	(75.39)
Dummy higher education	1,349***
	(322.9)
Dummy secondary education	600.9**
	(210.7)
Dummy primary education	16.16
	(27.70)
Dummy sex	215.9***
	(39.01)
Dummy credit	194.1**
	(70.92)
Total number of oxen owned	49.64**
	(16.76)
Farm land size	212.4***
	(35.15)
2009.year	129.3*
	(67.97)
Constant	1,476***
	(69.07)
Observations	2,214
Number of woreda	14
R-squared	0.667

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: own computation

When coefficients are estimated on the basis of clustering, the model doesn't give a value for F statistics. Besides, the joint significance cannot give meaningful results in such cases. Thus in

order to analyze the determinants of sufficient level of calorie intake, we are concerned with individual variable significance, rather than the joint significance.

In this section we present the discussion of the remaining priority variables which were not found to be significant in the conditional logit model but are significant in this model. Therefore a discussion of off farm income, fertilizer use and number of oxen owned is presented below. Besides, variable year 2009 is discussed.

Off farm income

Off farm income found to be significantly determining sufficiency of calorie intake at 1% significant level. In Ethiopian where productivity is constrained by many factors that contributes to insufficient calorie intake and food insecurity, diversifying income is worth practicing. In their study in Northern Ethiopia, Holden et.al (2004) stated, lack of employment restricts involvement in off farm activities. Had there been much employment, there would have been greater involvement than observed. For those households participated, off farm work has a positive impact on income, food security and hence food security.

It is true that the farming activities are only seasonal that matches with the rainy season. As already discussed irrigation farming is almost nonexistent. Thus, the intensive farm work lasts only from sowing in late June and early July till harvesting in November till early December. The rest are long break seasons for the farmers. This makes the households very susceptible to both economical and health crisis. As a conclusion, policy intervene should focus in creating job opportunities in the form of establishing factories and others so that those farmers can be involved in those works at least in their off farm periods.

Number of oxen owned

Similarly, this variable is found to be significantly determining per capita calorie intake/ sufficiency of calorie intake at 5% significant level. The result seems reasonable in a country like Ethiopia, where agricultural technology is not mechanized and oxen are the typical wealth for the farm households. So policy should intervene in the area animal health.

Fertilize use

Fertilizer use significantly determines sufficiency of calorie intake at 1% level of significance. While this is the situation, what is common in Ethiopia is that, farmers are constrained by financial capital to buy and use chemical fertilizer. Hence they usually use a minimal amount of fertilizer per hectare. So, government should think in making chemical fertilizer much more accessible by the famers.

Year2009

A joint test is conducted using "testparm" to determine if we need time fixed effects. The null hypothesis is that the time dummy for both years, 2004 and 2009, are equal to zero. The result, Prob>F is a less than 0.05 value suggesting that we reject the null hypothesis. Thus we used time fixed effects. The coefficient estimate for this variable is found to be significant at 10% level of significance. This suggest that there is an unforeseen factor that as increases the per capita calorie consumption as there is an additional one year increase. This result is also consistent with the fixed effects model.

5.3 Ordered Probit Model

In this model we have four categories. Table 11 shows the categories and the percentage frequency of food security status in each category. In an ordered probit model coefficient estimate, it is only possible to interpret the sign of the coefficient estimate and not the magnitude. Where as in the marginal effects estimate, it is possible to interpret both the magnitude and the sign. Besides in this model the sum of the marginal effects of a variable in the four categories would sum up to zero. This is due to the fact that if we have high likelihood in one category then we definitely have less likelihood in the other category. We have checked that the sum of the marginal effects of all variables in the four categories sum up to zero.

Based on table 11 food insecure households are 22.76% while severely food insecure accounts to 56%. This model provides more detailed information than the binary choice conditional logit which accounted 79% of the households are food insecure. This is in fact due to information clustering nature of binary choices. However ordered probit model does not consider the panel nature of the data and the regression is simulated by just considering the data as pooled cross sectional data. Hence it is not possible to include a time trend variable in this model.

Table 11. Categorical food security status

Food security status	Percentage
Food secure	10.16
Moderately food secure	11.07
Food insecure	22.76
Severely food insecure	56.01
Total	100.00

Source: own computation

As shown in the marginal effects in table 12 below exposure to rain fall shock decreases the likelihood of being in the food secure category, moderately food secure and but increases the likely hood of being in the relatively severely food insecure category. However this variable is not significant in this model. The rest of the variables estimate also reinforces the conditional logit and fixed effects model results except differences in magnitude and significance of the coefficient estimates. Generally in this model except rainfall shock which is not significant in any of the categories and higher education which is found to be significant in only two of the categories, the rest variables significantly determine the households in being in any one of the food security status.

Table 12.Ordered probit model estimation results

VARIABLES	(1) Foodsecure mfx dydx	(2) Moderately foodsecure mfx dydx	(3) Food insecure mfx dydx	(4) Severely food insecure mfx dydx
Dummy shock	-0.002	-0.011	-0.021	0.035
	(0.001)	(0.007)	(0.014)	(0.022)
Dummy land quality	0.016***	0.068***	0.116***	-0.201***
	(0.003)	(0.009)	(0.013)	(0.023)
Household size	-0.006***	-0.031***	-0.060***	0.098***
	(0.000)	(0.002)	(0.004)	(0.005)
Age household head	0.001***	0.002***	0.004***	-0.007***
	(0.008)	(0.001)	(0.001)	(0.001)
Dummy off farm income	0.006***	0.030***	0.057***	-0.094***
	(0.001)	(0.007)	(0.013)	(0.022)
Dummy fertilizer use	0.018***	0.078***	0.131***	-0.228***
	(0.003)	(0.009)	(0.014)	(0.023)
Dummy informal education	0.008*	0.036**	0.057***	-0.102**
	(0.004)	(0.016)	(0.020)	(0.041)
Dummy higher education	0.114	0.220***	0.087	-0.421***
	(0.084)	(0.077)	(0.059)	(0.103)
Dummy secondary education	0.091*	0.198***	0.102***	-0.392***
	(0.052)	(0.060)	(0.031)	(0.082)
Dummy primary education	0.004**	0.021**	0.038**	-0.065**
	(0.002)	(0.010)	(0.016)	(0.028)
Dummy sex	0.024***	0.097***	0.153***	-0.276***
	(0.004)	(0.010)	(0.014)	(0.024)
Dummy credit	0.019***	0.073***	0.105***	-0.198***
	(0.004)	(0.013)	(0.013)	(0.028)
Total number of oxen owned	0.004***	0.021***	0.041***	-0.067***
	(0.001)	(0.003)	(0.007)	(0.011)
Farmlandsize	0.013***	0.066***	0.129***	-0.210***
	(0.002)	(0.006)	(0.011)	(0.014)
Observations	2,214	2,214	2,214	2,214

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: own computation

Chapter 6: Conclusions and Recommendations

Despite many efforts by the government, ensuring food security in Ethiopia has been a challenge over the years. This suggests that there are still problems that call for action. Identifying and examining the determinants of food security in rural farm households can be taken as one step towards the solutions to the problems. Unlike the existing literatures which are region specific based on cross sectional data, the current study examines the determinants of food security in rural farm households using a two year panel data from ERHS. This data is collected from four different regions, for a total of over two thousand panel observations. Determinants of sufficiency of calorie intake or nutritional status have also been analyzed as a sub component of this study.

6.1 Conclusions

Conditional logit model is appropriate for panel data with a binary choice response variable. It allows to controll unobserved heterogeneity and rules out some biases in estimates. Based on the findings of this model, most of the variables that are fitted in to it exhibited the same sign as we hypothesized. Rainfall shock and household size have an odds ratio of less than one indicating that they are negatively correlated to food security. Besides, these variables significantly determine food security at varying levels of significance. In the literatures, rain fall in Ethiopia is taken to be the most limiting factor because of the rain fed nature of agriculture. Thus the current finding is consistent to the justifications. Besides, an additional increase in household size decreases the likelihood of the household to be food secured. The justification lies, an additional family is a pressure as it shares from the given entitlement to resources.

Land size and land quality are positively correlated to foods security and significantly determine it. The rationale behind is that, even with optimal management, an access to greater farm size and better land quality tends to result better productivity. However, there are literatures which state smaller farm sizes provide better yields. But this is only possible if there are investments in land improvements. Credit access, found to be significantly determining food security. Households with access to credit are capable enough to diversify their income that can contribute to ensuring food security. Yet access to credit is very minimal for the rural farm households. Generally, these are among the priority variables that are found to be significant in the conditional logit model.

Examination of food security status of the conditional logit model indicated that, in the study period, food insecure households are 79%; while food secure households are only 21%. This suggests that immediate intervention must take in place. Analysis of food security status overtime has also been computed. The result suggests that there is an improvement in food security status from 18.97% to 23.49%, as we go from year 2004 to year 2009 respectively, even if the improvement is not that much significant. Besides, analysis of regional mean values for food secured households has been conducted. On average, around 69% of the food secure households experienced rain fall shock in Tigray region. This value is much more than the remaining three regions and the overall average value which is only 35%. Land quality is also the lowest in this region. Considering this food secure households in Tigray region seemed only marginally secured.

Fixed effects model is also appropriate for our panel data as it enabled us control for district heterogeneity. Basically, we used this model to analyze the determinants of sufficiency of calorie intake or nutritional status. According to the justifications presented, nutritional status in the current study is considered only in the context of sufficiency of calorie intake. Note that food security is also computed from calorie intake level. Thus the same sets of variables that are fitted in to the conditional logit model are considered to affect sufficiency of calorie intake or nutritional status.

Based on the findings of this model, the same sets of priority variables that are found to be significant determinant in the conditional logit model, found to be significant in this model as well. Thus, farm land size, household size rain fall shock and credit access significantly determine sufficiency of calorie intake or nutritional status at varying levels of significance. Additionally three more priority variables, fertilizer use, oxen ownership and off farm income positively and significantly determine it. Besides coefficient estimates of all variables in this model reinforces the conditional logit model results. This is in a way that the variables in both models exhibited the same sign even if with different magnitude and significance level. This is due to the fact that the same per capital calorie intake is the bases for the response variables in both models.

Orderd probit modle is employed as it allows flexibility than conditional logit. However it does not have room to consider the panel nature of the data. Yet it is useful to compare the results. In this model four categories of food security status are created. Accordingly, while the food secure and moderately food secure households accounts to 10% and 11%, the food insecure and

severely food insecure household's accounts to 23 and 56% respectively. Besides, the results of this model reinforces both the conditional and fixed effect model results in a way that the coefficient estimates are similar in sign to the above models even if with differences in magnitude and significance.

6.2 Recommendations

We have seen many variables significantly determine food security and sufficient level of calorie intake. The question now is how to prevent the adverse consequences caused by entitlement failure to these determinant factors. It is true that efforts are being made in addressing this and related country problems. Yet, we would like emphasize that sound policy intervention must take in place.

Despite the huge potential for irrigation the current utilization is very minimal accounting to only less than 1%. Exploiting the existing irrigation potential, can thus provide endurance to shock caused by early interruption of rain fall. Similarly climatic adoption strategies like timely provision of rain fall data, late and early planting and selecting crop varieties can be remedy to irregularities in rainfall that can aggravate the current food security situation. Land improvement, mechanized farming, and use of chemical fertilizer are another set of areas of intervention. Besides, relocating and resettlement of population from more densely populated area to a lesser one seems sound to practice. For example relocating people from the highly densely populated region SNNPR to lesser ones, Gambela and Benishangul, can be one of the solutions to the problems.

Generally these all sets of policy interventions are "externalities" to the farm households. However, the households themselves are decision makers who need to maximize their wellbeing. Thus in order to be practical interventions must consider the net benefit to the farm households. Besides policy intervention should start from the more disadvantaged region.

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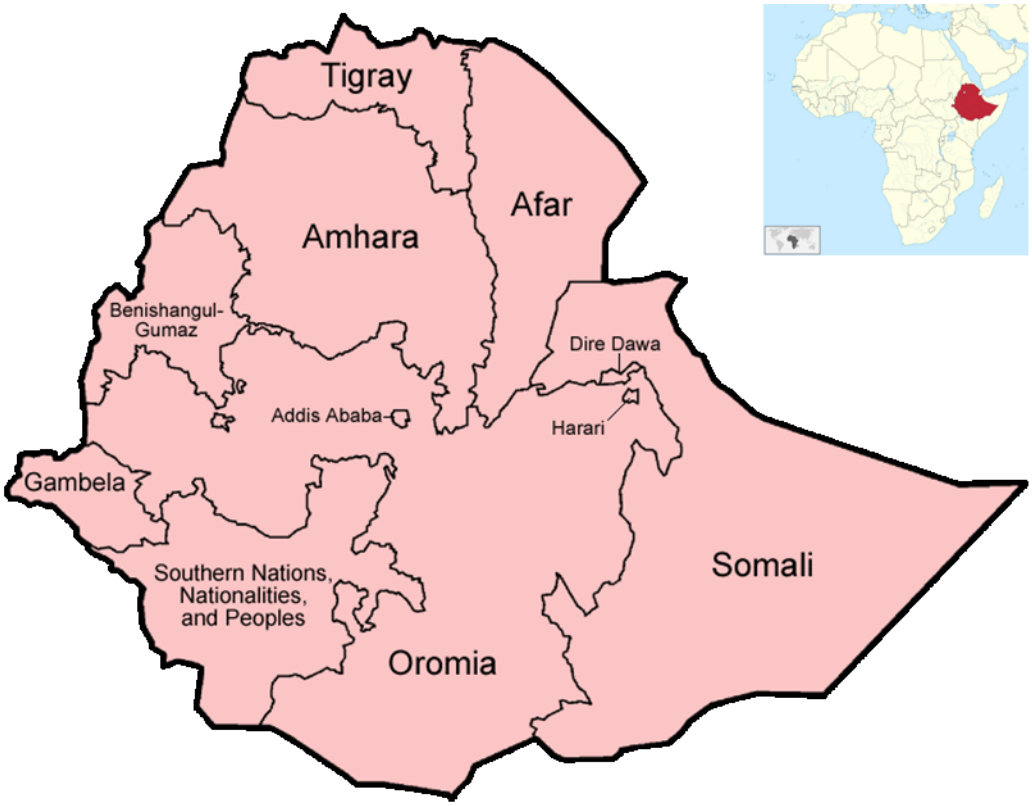
Appendices

Appendix I. Regional map of Ethiopia



(Sources: http://upload.wikimedia.org/wikipedia/commons/0/05/Ethiopia_regions_english.png and http://commons.wikimedia.org/wiki/File:Ethiopia_in_Africa.svg)

Appendix II.Composition of foods commonly used in Ethiopia

Description of food/grains	Composition in terms of 100 grams edible portion Food energy in Calories
Barley,black,Hordeum vulgare L.: whole grain	370.80
Barley,white,Hordeum vulgarel.:whole grain	372.30
Corn(maize),Zeamaysl.:yellow,whole grain	375.10
Corn(maize),Zeamaysl.:white,whole grain	375.00
Emmer,wheat,trticum dicoccum.:wholegrain	359.9
Millet,Eleusine coracana(l.),black,whole grain	350.50
Rice,oryzasativa,whole grain	357.20
Sorghum,Sorghum spp:,red,whole grain	380.50
Sorghum,Sorghum spp:,white,whole grain	359.20
Sorghum,Sorghum spp:,mixed,whole grain	369.90
Tef,Eragrosstis tef(Zucc.) Trott.:,red,flour	355.10
Tef,Eragrosstis tef(Zucc.) Trott.:,white,flour	358.8
Tef,Eragrosstis tef(Zucc.) Trott.:,mixed,flour	358.90
Wheat,triticum vulgare Vill.:,white,whole grain	362.30
Wheat,triticum vulgare Vill.:,mixed,whole grain	357.40
False banana,Ensete ventricosum.:flour	196.00
False banana,Ensete ventricosum.:kocho	211.10

Source : EHNRI(1995-1997)

Appendix III. Summary of regional mean values of all households

Variable	Tigray	Amhara	Oromia	SNNPR
Farm land size	.663233	1.134645	1.185793	.4969243
Total number of oxen owned	.676259	.974026	1.085044	.3876263
Dummy Credit	.2482014	.3095238	.5146628	.3661616
Gender	.2625899	.4112554	.4428152	.3169192
Dummy illiterate	.647482	.525974	.4222874	.5366162
Dummy primary education	.0899281	.1363636	.21261	.334596
Dummy informal education	.0431655	.1645022	.1055718	.0189394
Dummy fertilizer use	.2374101	.3636364	.6202346	.2765152
Dummyoffarm income	.471223	.4480519	.4941349	.3143939
Age	47.70504	50.25974	43.81965	49.23737
Household size	5.600719	4.917749	6.105572	6.109848
Dummy land quality	.0899281	.3722944	.4750733	.4078283
Dummy shock	.7877698	.4805195	.431085	.4684343

Source: own computation

Appendix IV. Food security status for a less than average farm land size holdings

sum region woredanew numerhhidnew if farmlandsize<=.8630803& secure==1

Variable	Obs	Mean	Std. Dev.	Min	Max
region	79	3.772152	1.967358	1	7
woredanew	79	384.6962	201.2924	101	716
numerhhidnew	79	4.32e+13	3.72e+14	1.10e+10	3.31e+15