THE LINK BETWEEN FOOD SECURITY AND LAND DEGRADATION: ANALYSIS OF DETERMINANTS IN DROUGHT PRONE AREAS OF NORTH EAST ETHIOPIA. *A CASE OF SEKOTA WOREDA.*

MASTER OF ART (M.A) THESIS

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Title

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DEDICATION

In loving memory of

MY FATHER, (C/o) FUFA LETA BULTO,

Died in February 2001

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LIST OF ABBREVIATIONS

ACSI	Amhara Credit and Saving Institute
ADLI	Agriculture Development Led Industrialization
AE	Adult Equivalent
ANRS	Amhara National Regional State
CSA	Central Statistical Authority
EEA	Ethiopian Economic Association
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
Ha	Hectare
HARC	Holleta Agricultural Research Center
HH	Household Head
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
Kcal	Kilocalorie
LPM	Linear Probability Model
m.a.s.l	Meter above sea level
MEDaC	Ministry of Economic Development and Cooperation
MoPED	Ministry of Planning and Economic Development
MT	Metric Tone
NCS	National Conservation Strategy
NGO	Non Governmental Organization
SCRP	Soil Conservation Research Project
SERA	Sustainable Agricultural and Environmental Rehabilitation in Amhara region
SDARC	Sekota Dry land Agricultural Research Center
SM	Sub moist
SPSS	Statistical Package for Social Science
SWC	Soil and Water Conservation
TLU	Tropical Livestock Unit
USAID	United State Agency for International Development
VIF	Variance Inflation Factor
WHAZ	Wag Himra Administrative Zone
WADO	*Woreda* Agricultural and Development Office

ABSTRACT

Land degradation, which is mainly exhibited by soil erosion and nutrient depletion, reduces the productive capacity of the land which poses a serious threat on food security status of households. So far, various studies attempted to study the causes of land degradation and low productivity independently, and little is done on exploring the linkage between food security and land degradation. Thus, the present study was envisaged with objectives of exploring the linkages between food security and land degradation and identifying determinants of food security and coping strategies at household level in Sekota woreda. A two- stage sampling procedure was employed to select 140 sample households from six sample kebeles. The basic data used for this study were collected from sample households, focus group participants and key informants through structured questionnaire and semi-structured checklist, respectively. The survey result revealed that out of the total 138 sample households, 95 households (68.8%) were found food insecure while the remaining 43 households (31.2%) were food secure. Descriptive statistics and binary logit regression model were employed for analysis, in line with the stated objectives.

The results of the study exposed that land degradation, mainly in the form of soil erosion, is the third main cause of food shortage next to shortage of farmland and rainfall variability at household level. In addition, the study results confirmed, that the pervasive land degradation is the primary cause of decline in agricultural production and subsequent food shortage at household level. This situation is further exacerbated by the rugged topography, recurrent drought and ever increasing population growth in the study area.

Results of the study also identified various socio-economic and bio-physical factors that influence the food security status of households. The binary logit model results disclosed that among 19 explanatory variables included in the model, 8 were found to have significant effect on household food security status. These significant variables include age of household head, dependency ratio, size of cultivated land, total number of livestock owned (excluding oxen),number of oxen, manure application, land quality index and farmer's knowledge on the effect of land degradation on food security. At last, the study concluded that policy makers and development agents must give attention and high priority in improving the economic access of the resource poor small scale farm households, which enable them to maintain land productivity and thus improve food security status. Moreover, due attention and policy consideration has to be given by government to those significant variables which have a potential impact in determining household food security status in the study area.

1. INTRODUCTION

1.1 Background of the Study

Ethiopia has been known for its wide spread poverty and devastating famines which occurred in the mid 1970s and 1980s. According to Sisay (2003), the country faced problem of severe food insecurity supported with the evidence of lowest kilo calorie intake in Africa which is about 1845 Kilocalories per person per day. This figure is less than the world minimum standard of 2100 Kilocalories for survival and much less than the recommended standard for an adequate diet which is 2400 kilocalories. In fact, the per capita food output of the country has been declining for nearly over 30 years and the ability to feed the population growing at about 3% per annum is deteriorating from bad to worse (Astatke, 2002). According to MoFED (2006) in the worst crop year, up to fifteen million people in the drought-prone areas of the country could face food shortages, which are either *chronic or transitory* in nature.

Ethiopian agriculture appears to be locked into a downward spiral of low and declining productivity (Devereux, 2000). The same author mentioned the result in Befekadu and Berhanu (2000) stating that, cereal yields have virtually stagnated, rising by only 0.5% per annum between 1980 and 1996 from 1.19 to 1.26 tons per hectare. This low productivity rate is mainly attributed to an adverse combination of agro-climatic, demographic, economic and institutional constraints, trends and shocks (Devereux, 2000). Furthermore, studies under score that the principal causes of inadequate growth in food production and increasing food insecurity are: inadequate and unreliable rainfall, soil degradation, civil war and ethnic conflicts, poor transport

and infrastructure, misguided economic policies such as land tenure, geographical diversity, rapid population growth, outdated production technology and small landholding, lack of storage, disease, inadequate nutritional knowledge, heavy workloads for women, etc (FDRE, 1996; Chung *et al.*, 1997; Wolday, 2004).

This backdrops is manifested in, the contribution of agriculture in the overall GDP and in employment levels which has declined continuously. The sector accounted about 68.6, 55.9 and 48.7 percent of GDP during the Imperial, *Derg* and current (EPRDF) regimes. Employment shares of agriculture were 88.6, 89.3 and 79.6 during the respective periods. Agriculture remains, however, the principal source of income and employment for the majority of the population in the country (Befkadu, *et al* (2002).

As indicated in Gete (2000) an investigation of soil erosion processes in Ethiopia showed that every year billons of tons of soil are detached from the soil mass and a large proportion of it leaves the country. Previous studies, as quoted by the same author, noted that Ethiopian highlands had the highest level of soil erosion compared to other countries. He further asserted that land degradation, mainly caused by soil erosion in Ethiopian highlands, has reached to a stage that sustained production could not be maintained.

In agricultural based economies like Ethiopia, a growing population demand both additional resources and new employment opportunities. In the absence of major opportunities in and outside agriculture, population growth causes decline in resource-man ratio and depletes resources (Terefe, 2001). Land is critical agricultural resource

(Carlson *et al.*, 1993). However, all physical and economic evidences show that loss of land resource productivity is a serious problem and that with continued population growth the problem is likely even to be more worse in the future (Berry, 2003). Land degradation which is mainly manifested in the form of soil erosion and nutrient depletion from the top horizon, has become one of the most important environmental problems. The existence of extensive land degradation is a cause for low land productivity resulting in declining crop yield (Tweeten, 1993).

In Ethiopia, individual farmers production comprises the largest proportion of consumption by farm household (Wolday, 2004). Food security is thus highly dependent on the farm performance and in particular to the production level of the major food crops (cereals, pulses and oil seeds). This is because these crops account for more than 90% of the total area covered by temporary or permanent crops (EEA, 2000/2001 cited by Workneh, 2006). Given the importance of yield productivity as a source of growth in production in most rural households, impacts of land degradation on productivity is a theme of keen interest to this study so as to investigate, the links between food security and land degradation.

In order to address the challenges of food security at the national level, the government issued a program document entitled 'Ethiopia's Food Security Strategy' in 1996 and updated it in 2002. The document highlights the elements of the government's plan to achieve the overall objective of ensuring food self-reliance in food nationally and guarantee household food security in the long-term (FDRE, 1996).

To this end, the economic policy of Ethiopia aims at ensuring rapid and sustainable development through agriculture-based development strategy. The current strategy of Agricultural Development Led Industrialization (ADLI) aims mainly to promote linkages between agriculture and other sectors of the economy. Agricultural growth is seen as a guarantee to food security in the country. The food security strategy of Ethiopia is based on three important aspects: a) increasing food and agricultural production, b) improving food entitlement and c) strengthening capacity to manage food crises. In order to improve agricultural production major emphasis is given to increasing productivity through diffusion of improved technologies. In food entitlement strategy, the focus is on reducing vulnerability in drought prone areas. The strategy also focuses on strengthening emergency capabilities. It involves maintaining emergency food reserves and developing an effective early warning system (MEDaC, 1999).

In this manner, the Amhara National Regional State established institution like Food Security Coordination and Disaster Prevention Office in the year 2004 with the mandate and primal responsibilities of realizing food security at household level. Besides, a number of non-governmental organizations have been working on the area of food security. Despite these efforts, the prevalence of food insecurity together with problems of land degradation remained to be important challenges.

In the Amhara National Regional State (ANRS), as elsewhere in the country, the livelihood of the majority of the population is tied up with agriculture; mixing crop and livestock production (Ludi, 2002). In a society so dominated by crop and livestock production, survival is inextricably linked to land resources (Terefe, 2001).

However; many households are only able to produce sufficient food to meet their food requirements for less than six months of the year (SERA, 2001). According to USAID (2003), forty-eight out of one hundred five *woredas* of the Regional State were drought prone and suffered from frequent food shortages. Of these food insecure *woredas*, six of them are found in Waghimera zone.

Waghimera zone seriously suffered and is suffering from successive drought induced famine (Mesfine, 1984). The zone still suffers from recurrent drought that immediately follows before the wounds left by past successive ones heal. The situation is summarized well by Dessalegn (1987:2): 'the tragedy of the past fuels the tragedy of the future, and the specter of famine refuses to be exorcised'. Sekota *woreda* is one of the food insecure *woredas* in the zone. The ANRS Food security Coordination and Disaster Prevention Office (2007) report estimated that about 29% of the population is vulnerable to food insecurity.

Accordingly, the people are forced to relay on persistent food aid since 1984/85 (HARC, 2000). Hence, there is a pressing and urgent need to address this problem of farmers so that they can able to achieve food security through rapid increase in food productivity and production on economically and environmentally sustainable basis.

1.2 Statement of the Problem

Land degradation is a global threat to human population and has been described widely and gained public attention significantly since the Earth Summit in Rio de Janeiro, 1992 and the formulation of the Agenda 21.Avilable evidences leave no doubt that the issue of land degradation is a serious problem in East Africa, and elsewhere in Africa (Pender *et al*, 2004).

The Ethiopian government first recognized the severity of the soil erosion problems and its impact following the 1973-74 famine. With heavy external support, the government initiated a massive program of soil and water conservation using different approaches for its implementation. It is also widely acknowledged that the soil conservation policies and activities of the past decades have not been successful (Debele, 1994; Nedesa, 2002; Pender and Ehui, 2000 cited by Wagayehu and Drake, 2003). It is fair to say that the technologies focused narrowly on arresting soil erosion without fully considering the underlying causes of low soil productivity, socio-economic factors, and the need for tangible benefits to be attractive to poor farmers (Kumela, 2007).

Over the past few decades, rate of soil erosion by water have been brought more or less under control in any developed nations. But in the same period, many developing nations, particularly in Sub-Saharan Africa, have been severely affected by this form of land degradation. Ethiopia is one of the most severely affected countries in the Sub-Saharan region (Gete and Hurni, 2002).

Soil degradation is severe especially in areas of early settlement and agriculture such as Tigray, Wollo, Gonder and North Shewa. It is no coincidence that these areas were most severely affected by the droughts in the mid 1970s and mid 1980s (Hurni, 1988 cited by Ludi 2002).Soil erosion is the most significant ecological restriction to sustainable agricultural production, mainly under subsistence agricultural production system like the case of the Amhara region (Gete and Hurni, 2002).

Waghimera zone in general and Sekota *woreda* in particular, is one of the food insecure and moisture-deficit area in Amhara National Regional States (SERA, 2001). People living in the area have been suffering from problem of land degradation particularly in the form of soil erosion (HARC, 2000). Land degradation undermines the production capacity and thereby reduces agricultural production (Ludi, 2002). Consequently, low agricultural production has constrained ability of households to acquire sufficient food supply (Eyasu, 2002).

In the study area, most of the farmland had been cultivated for long period under traditional mode of cultivation. The unwise crop and livestock husbandry accompanied by the rugged topography has left most part of the land mass devoid of soil and natural vegetation which increasingly left much of the cultivated land out of production (SERA, 2001). Above all, shortfall of appropriate policy, environments related to land and natural resource management, institutional instability, population growth, and most important of all, lack of a clear understanding of land degradation and its impact at all levels plays a significant role in aggravating the crisis (Gete,2000).

The study conducted by HARC in 2000 which considered the 1998/99 production season revealed crop productivity in the area is 32.6 kilogram of grain/person/annum. Even in the best productivity year of (1995/96), the annual output in the area was about 176.5 kilogram of grain/person/annum. The same study cited the work of Holt and Dessalegn (1999) which considered the feeding habit in the country at large and the study area in particular, calculated about 240 kilogram is needed to satisfy the kilocalories per day requirement that should come from grain crop. Thus, even during the best productive year, the *woreda* fails to feed its population, let alone to rectify the drought effect of other years.

The problem of food security takes particular forms in its extent, causes and consequences at lower levels of analysis. Macro level analysis of the problem concealed important difference at the micro level, which would mask recommendations to widely varying problems. So far, no empirical studies were conducted at the study area in analyzing the linkage between food security and land degradation. Therefore, a move to examine the association between land degradation and household food security status together with other socio-economic and bio-physical determinants is very crucial to come up with appropriate interventions that could help the efforts in research, extension, rural financing and policy formulation.

1.3 Objectives of the Study

The general objective of the study is to explore the link between land degradation and food security among farm households in order to identify policy options for enhancing farm households' food security status in Sekota Woreda.

Given the problem discussed above, the specific objectives of this research are:-

1) To identify determinants of household's food security,
2) To explore the linkage between household's food security and land degradation,
3) To assess coping strategies of households in the study area.

1.4 Research Questions

In the process of data collection, data analysis and hypothesis testing, the study at minimum attempted to obtain sufficient data to provide answers to the following leading research questions:-

1) What are the biophysical, demographic, socioeconomic and institutional determinants for household food security?
2) How are land degradation, agricultural production and food security associated at household level?
3) What are the major causes of household food shortage and land degradation?
4) What are the coping strategies of households during food shortage in the area?

1.5 Hypothesis of the Study

1. Male, older and literate household heads who are relatively resource endowed with larger (size of cultivable land, labor, numbers of plots, land quality index and livestock number (excluding oxen), number of oxen are expected to be food secure.
2. Households who are aware of the problem of land degradation on food security and undertake responsive measures to land degradation (i.e. modern SWC and Manure application) are expected to be food secure.
3. Farm households with access to institutional services (i.e. extension service, credit service and market center) are expected to be food secure.
4. Households residing in *woina-dega* agro ecological-zone have better probability of being foods secure than those in *Dry woina-dega* agro-ecological zone.
5. Households who are no crop pest problem in their field and low dependency ratio are expected to be food secure.
6. Households who have access to off-farm are expected to be food secure.

1.6 Significance of the Study

Land degradation in general and soil erosion in particular is the most serious environmental problem threatening the Amhara National Regional State (ANRS). Since the well-being of the population is highly interrelated to land, particularly soil, it has to be managed properly and economically in sustainable manner.

Hence, it is crucial to identify appropriate policies to increase agricultural production and food supply for economic growth and sustained development. For assurance of food security and sustainable management of land resources concerned actors: the smallholder farmers, the public, policy makers, bilateral and multilateral donors, researchers, and other development agencies need an adequate empirical evidence and information.

Suffice to say, this thesis provides evidences about how the different problems food shortage, low productivity and land degradation are interlinked to one another at household level. Thus, this information would benefit much the respective development practitioners working in the area of food security and natural resource rehabilitation in both governmental and non governmental organization in the *Woreda* and elsewhere in similar scenario.

1.6 Scope and Limitations of the Study

Research is a resource intensive pursuit of wisdom. It requires the appropriate technical, financial and geographical qualifications. As a study for the partial fulfillment of the academic rank, this research report is submitted with the belief that it is sufficient for its purpose. Yet, there are a lot of undeniable facts that limits free dependence on and extrapolation of the outputs of this scientific effort.

The period with in which the study is conducted was too short to indicate any trend if there is in the farming system so far as problem of food shortage and land degradation are concerned. In fact, the entire reliance on farmers' knowledge and anticipation can fill this gap, but partially.

Notwithstanding, the fact that cross-sectional studies are reliably appropriate for specific purposes, analyzing linkages of food security and land degradation demands measuring the process overtime. Furthermore, the delimitation of the study area to a single *woreda* and 138 sample households determine the scope of the study.

1.7 Organization of the Study

The thesis is organized into seven chapters. Chapter two presents the theoretical reflection and the conceptual framework of the research. This outlines the interplay between food security and land degradation through theoretical concepts and definitions, going deeply into causes and consequences of land degradation and linkage between food security and land degradation, with the empirical results in determinants of household food security. Chapter three describes methodologies pursued in identifying sample households, data collection and analysis. It gives also brief account of analytical framework. Chapter four provides description of the study area. It summarizes the topography, climate, natural resources and farming practices. Chapter five and six presents a discussion in the findings of the study and econometric model analysis of the determinants of food security respectively. Finally, a number of concluding remarks are set out in Chapter seven.

2. LITERATURE REVIEW

The following section presents an overview of the salient issues of food security with its methods of measurement, indicators and households coping strategies. Thereafter, tries to cover perspectives on land degradation in relation to its effect on agricultural productivity, food security and highlight few empirical studies done on determinants of food security. Finally the conceptual framework drawn from the theoretical perspectives on food security and land degradation is presented.

2.1 Concepts and Definition of Food Security

The concept and definition of food security has been familiar since for quite a long period because of the growing hunger and malnutrition scenarios in developing countries. In the 1970s, food security was mostly concerned with national and global food supply, and then in the 1980s the focus shifted to questions of access to food at household and individual levels (Sen, 1981). A crucial component that was identified is individual's ability to utilize the food to which they had access. Hence, food availability, access and utilization are the three general components in the definition of food security (Smith *et al*, 1992; Wiebe and Maxwell, 1998).

Definitions of food security may vary but the overall basic principles and definitions of food security, mainly; "availability and access" has been stressed in most definitions as can be seen in the following definitions.

The most-cited definition of food security is taken from a World Bank policy study, published in 1986: 'Food security is access by all people at all times to enough food for an active and healthy life'. The essential elements of the definition are availability

of food and the ability to acquire it. Based on this food security is elaborated by focusing on two features that sharpen focus on access to food. First, it requires that access be sufficient for activity and health by measuring sufficiency in terms of caloric intake relative to physiological requirements for a specified period. These requirements may vary with individual characteristics (age, sex, level of physical activity) and with environmental characteristics (like climate, quality of water and health) to which the household has access. Secondly, it must be sustainable. This is because a household can hardly be considered as food secure if it is able to meet its current nutritional requirement only by selling or depleting its endowment of resources. In view of these features, food insecurity is defined as the lack of access to enough food.

Food insecurity is classified as chronic or transitory. Chronic food insecurity is a continuously inadequate diet caused by the inability to acquire food as it affects households that persistently lack the ability either to buy enough food or to produce their own, whereas transitory food insecurity is a temporary decline in a household's access to enough food as a result of instability in food prices, food production or household incomes (World Bank, 1986).

Similar to the above World Bank definition of food security Von Braun *et al* (1992) define it as 'access by all people at all times to the food required for a healthy life.' In this case, access to the needed food is a necessary but not sufficient condition for a healthy life. This is because besides access to food a number of other factors must be considered, such as health, sanitation, environment and household or public capacities to care for vulnerable members of the society also come into play.

On the contrary, Wiebe and Maxwell (1998) interpret sufficient access at all times, as access to food should be sufficient under all possible circumstances within any particular period of time, which is based on the concept of vulnerability. The vulnerability (risk) profile of individual households and communities is determined by the channels through which their access to food is normally mediated and by the assets which are available to them as buffers. Therefore, according to this definition, the most food insecure households are those facing the greatest probability of an entitlement failure with the least assets. If the risk should materialize, these households have no choice but to bear the costs of an entitlement failure in the form of reduced dietary intake, either in the current time or in the future. Even where asset holdings are larger, households may be reluctant to dispose of productive assets to safeguard current food consumption, because of the opportunity cost in terms of future food access. However, there will come a point when it is no longer rational to protect future entitlement by under consumption if the household will not survive the current period by doing so (Smith *et al*, 1992).

From the above definitions, four core concepts, implicit in the notion of "secure access to enough food all the time" are identified by Smith *et al* (1992). These are (a) access to enough food, defined by entitlement to produce, purchase or exchange food or receive as a gift; (b) sufficiency of food, defined as the calories needed for an active and healthy life; (c) security, defined by the balance between vulnerability, risk and insurance; and (d) time, where food insecurity can be chronic, transitory or cyclical. Therefore, for the purpose of this study, the definition forwarded by World Bank (1986) is taken as a working definition of food security.

2.1.1 Food Security: Measurement and Indicators

Studying food security at household level requires a consideration of multitude of factors. This is because food security at household level is influenced by different interrelated socio-economic, political and environmental factors. As a result, analysis of food security has been following diversified approaches ranging from a mere quantitative to a combination of both quantitative and qualitative measurements. These approaches vary based on the fact that, the purpose, level of aggregation and depth of investigation determines the utilization of indicators.

Consequently, the different types of indicators are classified into two categories; 'processes' and 'outcome' indicators. The process indicators provide an estimate of food supply (using meteorological data, information on natural resources, agricultural production data, and food balance sheet) and food access situation whereas the outcome indicators serve as proxies for food consumption. Furthermore, the outcome indicators are grouped into direct indicators and indirect indicators. The direct indicators are closest to actual food consumption while indirect indicators focus on storage estimates, subsistence potential ratio and nutritional status assessment. Therefore, direct outcome indicators are preferred to indirect indicators due to the fact that the latter show only availability or supply in the area which doesn't guarantee acquisition of food at the household level (Frankenberger, 1992:82 cited by Debebe, 1995).

Several methods have been used to measure food consumption; the first one is estimating both total household production and purchase over a period of time and growth or depletion of food stocks held over that period. Thus, food entering the

household possession and disappearing is presumed to have been consumed. The second estimate is to undertake 24hour recalls of food consumption for individual members of a household and analyze each type of food mentioned for caloric content (Bouis, 1993; cited by Wiebe and Maxwell, 1998).

According to Hoddinott (2001), there are four ways of measuring household and individual food security: individual intakes (either directly measured or 24-hour recall), household caloric acquisition (the number of calories, or nutrients, available for consumption by household members over a defined period of time), dietary diversity (sum of the number of different foods consumed by an individual over a specified time period), and indices of household coping strategies (an index based on how households adapt to the presence or threat of food shortages). These methods are ordered moving from methods that are very time and skill intensive, but are regarded as being more accurate, to those that can be implemented quickly, are relatively undemanding in terms of the skills required by the implementers, but are more impressionistic.

Even though, dietary diversity and indices of household coping strategies have advantage of being easy to train enumerators to ask these questions and individuals generally found them easy to answer and the later one can directly captures notions of adequacy and vulnerability, these methods have major drawbacks. For instance, the simple form of the dietary diversity measure does not record quantities and it is not possible to estimate the extent to which diets are inadequate in terms of caloric availability. On the other hand, indices of household coping strategies are a subjective

measure and its simplicity makes it relatively straightforward to misreport a household's circumstances.

As the result, since the level of analysis for this study is at household level due to the cost and time requirement constraints household caloric acquisition method is selected to measure the state of food insecurity at household level among four outcome indicators. For household caloric acquisition method the principal person responsible for preparing meals is asked how much food she/he prepared over a period of time. After accounting for processing, this is turned into a measure of the calories available for consumption by the household and dividing the calories figure by the number of adult equivalents in the household and the number of days in the recall period results in a concise figure for average calories consumed per adult equivalent per day, which is then compared with an estimate of caloric requirement.

2.1.2 Households Coping Strategies

In describing the concept of coping strategy/mechanism, common terms or phrases like "coping technique" and "survival methods" are often used interchangeably by writers and researchers. In this context, "coping strategy" means coping mechanism "or coping technique", implies mainly at a household and individual levels. The term "response" is also used for individual actions aiming at survival in the face of disaster-induced food crisis or famine. "Coping strategy" could be defined as a mechanism by which households or community members meet their relief and recovery needs, and adjust to future disaster related risks by themselves without outside support (Dagnew, 1994). According to Davies (1994), coping strategies are

the bundle of poor people's responses to declining food availability and entitlement in abnormal seasons or years.

Farm households respond to the problems caused by seasonal and disaster (mainly drought) related food insecurity in different ways. Various coping mechanisms that are identified by different authors (e.g., Messer, 1989; Dagnew, 1994) can be put under three broad categories. These are production-based responses (expansion of production and improving productivity); market-based responses (food grain purchase through mainly sales of livestock) and non-market-based responses (including institutional and societal income transfer systems such as gift and relief food distribution).

Coping mechanisms used by farm households in rural Ethiopia include livestock sales, agricultural employment, certain types of off-farm employment and migration to other areas, requesting grain loans, sale of wood or charcoal, small scale trading, selling cow dung and crop residues, reduction of food consumption, consumption of meat from their livestock, consumption of wild plants, reliance on relief assistance, relying on remittances from relatives, selling of clothes, and dismantling of parts of their houses for sale. Some of them are likely to be implemented only after the possibilities of certain other options have been pursued (Cutler, 1984). In addition, households who have diversified source of income are often able to cope with crisis than others (Yared, 1999).

Coping mechanisms provide valuable guidance in designing food policy and in selecting, customizing and implementing instruments of interventions. Different intervention mechanism can be mapped to different patterns of coping mechanisms and specific thresholds (distribution) of insecurity call for some specific policy- mix. Moreover, since most coping strategies adopted during periods of crisis are extensions of those used in 'normal' years, monitoring households coping strategies would deepen our understanding of the root cause and characteristics of food insecurity.

2.2 Land degradation

2.2.1. Definition of land degradation

Land degradation has been defined in several ways. Some of the definitions are very general and address to all types of processes leading to a negative change in productivity of land under all types of uses. For instance, as a general term, land degradation is defined as "substantial decrease of biological productivity of a land system as a result of human activity, rather than natural events" (Turkelboom, 1999 cited by Ludi, 2002). Likewise, land degradation is defined as the temporary or permanent lowering of the productivity of land (Young, 1997 as cited in Tesfaye, 2003). Others are restricted in spatial coverage. It becomes a matter of perception dependent on one's preferences, production objectives, and value systems at large. According to Carucci (2000) land degradation is a progressive reduction of the capacity of the land to sustain life and provide food security. Accordingly, for this study land degradation is defined as a decline in the productive capacity of the land in relation to actual or possible uses and hence a problem for those who use the land (Woldeamlak, 2003; Berry, 2003).

2.2.2 Major forms and extent of land degradation in Ethiopia

Land degradation includes soil erosion, soil nutrient depletion, salinity, changes in soil structure, and chemical contamination (Haw *et al.*, 2000). All these are included under three category namely physical (include water and wind erosion, crusting and sealing, compaction, water logging and reduced infiltration), chemical (acidification, salinization, nutrient depletion, pollution) and biological degradation (soil organic matter decline, biomass burning and depletion of vegetation cover and soil fauna) (FAO, 2001).

Land being the critical agricultural resource, it is the basis for survival of most people in Ethiopia. The largest proportion of the GDP and employment for labor is contributed from the agriculture sector. However, land is seriously threatened by land degradation throughout the country, threatening both the economic and survival of the people through its adverse effect on the decline of agricultural productivity leading to more and more food insecure rural households.

Soil degradation is a specific subset of land degradation that describes a decline in the soil quality encompassing the deterioration in physical, chemical, and biological attributes, which commonly manifest itself through soil erosion, soil fertility depletion, soil compaction and soil pollution (Alemneh *et al.*, 1997).

In much of the Ethiopian highlands, soil degradation that is caused by soil erosion has reached a stage where it is increasingly difficult to maintain the present day production of basic foods, a level that is already insufficient in some regions (Gete,

2003). The Soil Conservation Research Project (SCRP) has estimated that about 1.5 billion tones of soil are eroded every year in Ethiopia (FAO, 1995)

Soil erosion is not a new phenomenon: it has been a problem since human beings started cultivating the land (Gete, 2000). Soil erosion is a natural process that has taken and will always take place. Problems arise when the natural process of soil erosion is accelerated due to human interventions that result in deviations from the equilibrium (Wagayehu, 2003).

2.2.3. Major causes of Land degradation

Consensus on the real causes of land degradation is lacking and several causes of land degradation have been hypothesized. For instance, according to Pender *et al* (2004) population growth, agricultural practices, wars and political instability, physical forces (topography and rainfall) and land tenure institutions are mentioned. Other studies tried to identify the well known proximate causes of land degradation: deforestation, overgrazing, limited soil and water conservation measures, limited application of nutrients/organic matter, burning of dung and crop residues and declining use of fallow (FAO, 1995; Wagayehu, 2003; Pender *et al*, 2004).

Similarly, a study made in north western Ethiopian highlands by Gete (2000) concluded the absence of sound land use tenure policies (frequent changes in the tenure systems and frequent distribution of land), population pressure, weak economic development strategies, unstable institutional frameworks, and weak link between research and extension have all been found to be root causes of land degradation. The major causes of land degradation that are believed to have important role for this study are discussed below.

Population increases during the past decades has increased the pressure on natural resources, especially arable land. People are forced to plough more and more areas unsuitable for crop cultivation and arable land has to be used more intensively. Fallow periods are shortened, if not abandoned altogether. Many hypotheses have been developed considering population as a cause of land degradation, following the dismal predictions of Thomas Malthus, population pressure is a cause to poor soil fertility leading to decreasing crop yield (Million, 1996).

Some researchers on the other side argue that population pressure is not always a cause to soil degradation. Significant numbers of studies from Africa have presented the optimistic view that the population increase leads to intensification of production, tree planting and conservation activities, for example the Kenyan Machakos district (Yohannes, 1999; Atakilite, 2003). Though there are controversial arguments concerning population growth, different studies (FAO, 2001; Pender *et al.*, 2004) have shown that in Sub-Saharan African countries including Ethiopia support the pessimistic hypothesis of Malthusian classical thought of population growth i.e. "more people-high erosion" has shown a cause to land degradation.

Deforestation is a process as old as human land use. Natural vegetation has mostly been cleared to gain grazing land and arable land. Remaining forests and bush areas are heavily utilized to collect fuel wood and construction wood. With increasing population and diminishing forest resources fuel wood requirements exceeded the natural regeneration capacities of the last remaining forests (Ludi, 2004). Nowadays forest resources are concentrated on only 4.6% of the total land area. Nevertheless,

deforestation continues at alarming rates. Similar to deforestation, overgrazing is a serious problem in north and central Ethiopian highlands. Especially in rainfall-insecure areas livestock is very vulnerable because feed resources are extremely low. There is also considerable migration to the dry lands and conversion of dry lands into croplands. This conversion is probably the main cause of deforestation of dry land forests and degradation of ecosystems. Water infiltration into eroded land is poor. Part of it runs off and part is evaporation. A consequence of this is drought and crop failure often leading to famine such as the chronic ones of Ethiopia (McClelland, 1997).

Agricultural mismanagement of soil and water resources includes non-adoption of soil and water conservation practices, improper crop rotation and use of marginal lands (FAO, 2001). In Africa, the contribution of different management factors towards land degradation is estimated to be 49%, 24%, 14%, 13% and 2% for overgrazing, mismanaged agricultural activities, deforestation, overexploitation and industrial activities) respectively (Vanlauwe *et al.*, 2002; cited in Tilahun, 2002).

Lack of early awareness about soil erosion and soil fertility decline by farmers is another possible cause of land degradation (Tilahun, 2002). These all are direct causes of land degradation primarily by human intervention exposing natural resources to depletion and loss. Human interventions expose the soil to erosion and induce depletion of natural capital assets of societies (Wagayehu, 2003). Laws and regulations over communal and private lands, customary rights of land use etc., are important factors that may contribute to land degradation. The absence of a well

defined legislation determining property rights over private holdings discourages long term investments in land protection and conservation.

2.2.4. Consequences of Land degradation

Consequences of land degradation is analyzed in terms of the loss of value within the environmental-economic system .The lost value is related to the productivity of land for agriculture and the environment as host of naturally occurring species of flora and fauna or to the environment (Gretton and Salma, 1997).

The effects of land degradation on agricultural productivity are manifested through their impacts on both, the average and variance of yield, as well as the total factor productivity of agricultural production. Land degradation affects agricultural productivity, leads to clearance of forests and native grasslands as existing land loses productivity, places demands on other natural resources to repair the land (lime for neutralizing acidity, water for flushing irrigation salinity) and leads to off-site pollution and loss of productivity and amenity values (FAO, 2001;Gretton and Salma, 1997). These impacts are translated into economic costs in the form of loss of income (or consumption), increased income risk and increase costs of production. To substantiate this with some evidence, the Ethiopian Highlands Reclamation study estimated that between 1985 and 2010 the rates of land degradation will cost 15.3 billion Ethiopian Birr, most of which 78% is due to crop failure or low yields and 22 % is due to decreased live stock population (Thomas, 1991).

Through its effect on agricultural production, land degradation results in decreased food production, drought, ecological imbalance and consequent degradation of the quality of life. To illustrate this further, soil erosion reduce productivity of the soil by

removing the topsoil which is fertile, chemically and biologically active. According to Belay (1992) as cited in Bamlaku 2005, a study in southern part of the Ethiopia highlands revealed that the topsoil remarkably lost more than half of its depth as the result of soil erosion by water. Therefore, the deterioration of these physical, chemical and biological properties of the soil results a significant decline in crop yield and crop productivity has been induced. In addition, to its natural capital asset depleting effect, soil erosion also induces immediate on site effects, those that happen at the site where erosion occurs, and off-site effects, which have positive or negative effects as the soil leaves the boundary or the field due to erosion and enters another field or watershed (Wagayehu, 2003).

2.2.5. Farmers' perception about land degradation

The responses, commitments and responsibilities required for the success of formulation of appropriate resource management policies depend on perception of the problem by smallholder farmers (Ayalneh, 2002). Farmers' decisions to conserve natural resources are largely determined by their knowledge of the problems and perceived benefits of conservation (Aklilu and Graff, 2004).

Farmers are aware of the problems of land degradation in its different forms in different ways. In this manner, Tesfaye (2003) reported farmers' view of land degradation problems in his case mainly in terms of soil erosion and soil fertility problem as follows: For farmers, soil movement is not that apparent unless rills and gullies are created. Their concern with soil is fertility that they measure using different indicators i.e its color (dark or light), compare the trend of crop stand and yield, and they see its physical characteristics such as weight on the plough shear and plough depth, stoniness and the like. Farmers tend to give soil erosion a lower priority

than soil fertility when ranking the different forms of land degradation; however, this view does not mean that farmers are not concerned with soil erosion and he concluded in their view, soil fertility takes precedence over erosion and the entrance point to their minds and hearts is through soil fertility..

Similarly, Yeraswork (1985) in their study on Ethiopian farmers' attitude towards land degradation and conservation revealed farmers awareness on the problems of land degradation. In this case, the farmers identified soil erosion as the main cause of land degradation, followed by drought, deforestation, rainfall and improper farming practices. The farmers further explained the effects of land degradation by mentioning famine and drought in general and reduction in yield in their farmland by comparison of the trend of crop yield.

Farmers' view of erosion problems and their conservation knowledge and practices in the *Beressa* watershed in the central highlands of Ethiopia was also studied by Aklilu and Graff (2004) and confirmed about 72% of the farmers perceived soil erosion problems as the major form of land degradation. The study further investigated the perception of farmers and found out that most farmers perceive erosion when it's sever mostly when visible signs of rills and gullies appear on their fields.

2.2.6. Measuring Land degradation

Many studies have attempted to measure land degradation through changes in soil chemical properties and soil erosion indicators (Maitima *et al*, 2004). Others mentioned in Tesfaye (2003) suggest that the views of different actors should be considered in measuring land degradation as all have their on perceptions on land degradation process and criteria. From land users' point of view, resource-users have

there own reasons as to how they manage their environment, therefore their perception on the process of land degradation and land management has to be considered to measure the extent of land degradation.

Therefore, the approach used for this particular study to measure land degradation is through farmers responses based on their perception, For this purpose, land quality index is developed as a proxy variable for measuring the extent of land degradation on farmer's plots. For instance to identify areas affected by soil erosion, certain features like soil removal (i.e. level of soil depth), signs of water runways like rills and gullies (i.e. severity of erosion) and accumulation of soil or sedimentation (i.e. slope category) could be quiet obvious on the landscape (Bamlaku, 2005).

2.3 Linkage between Food Security and Land degradation

Land degradation and food insecurity are pervasive and interconnected problems in Ethiopia. The prolonged effect of land degradation has resulted in erratic rainfall causing severe droughts at irregular intervals and these droughts threaten the lives and livelihoods of millions of people. Drought caused by erratic rainfall brings incapability of farmers to acquire food and hence causes extreme food crises. Land degradation in the form of soil erosion and nutrient depletion affects household's production and investment decision. Soil erosion affects soil depth, which in turn affect yields and output in the following years that have direct impact on income and welfare (Holden and Bekele, 2004). Furthermore, the same authors study at Andit Tid reported that yields are lowest and decline most rapidly on shallow and steep slopes.

About 50 % of the total area of the country is under the threat of soil degradation and impact of this is causing decline in food production by one to two per cent per annum (NCS, 1990). The most severe degradation, however, is observed in the northern highlands (Constable, 1984).The *Wollo* highlands (>1500 m.a.s.l) are one of the mostly affected areas in the northern part. As a result about 72% (5,817,600 ha) of the highlands is covered by very shallow soils which are less than 25 cm depth (Hurni, 1988). Such shallow soils are characterized by very low moisture holding and infiltration capacities, and hence undermine the ability of crops to withstand drought, exacerbating the decline in crop yield. It is obvious that these shallow soils are closely associated with recurrent occurrence of drought and famine in the area (Webb and Von Braun, 1989).

According to Tilahun (2002) a direct link between land degradation and rural livelihood was drawn mainly through three pathways. The first pathway is that decline in soil fertility as a result of land degradation decreasing farm productivity and income. As crop/livestock production is the major source of household income in the highlands, decline in soil fertility, through nutrient depletion and poor soil and water holding capacity affects the on-farm income significantly. The second path is decline in soil fertility affecting productivity of labor. This is because a degraded land requires much more labor that competes with off-farm income of the households. The last pathway is that land degradation reduces the underground and above ground biodiversity of the system, which in turn, affects the biochemical process of the rhizosphere and the vegetation cover of the land.

Moreover, the current level of poverty is further aggravated by reduced productivity of the soil which is caused by unabated land degradation in the country (Gete, 2000). This forces the people to live under vicious circle of poverty with one aggravating the other. To this end, the link between land degradation and livelihood indicate that land degradation and food insecurity are closely interconnected problems, measures or strategies to reverse land degradation help in improving food security status of a nation (Wiebe, 2002).

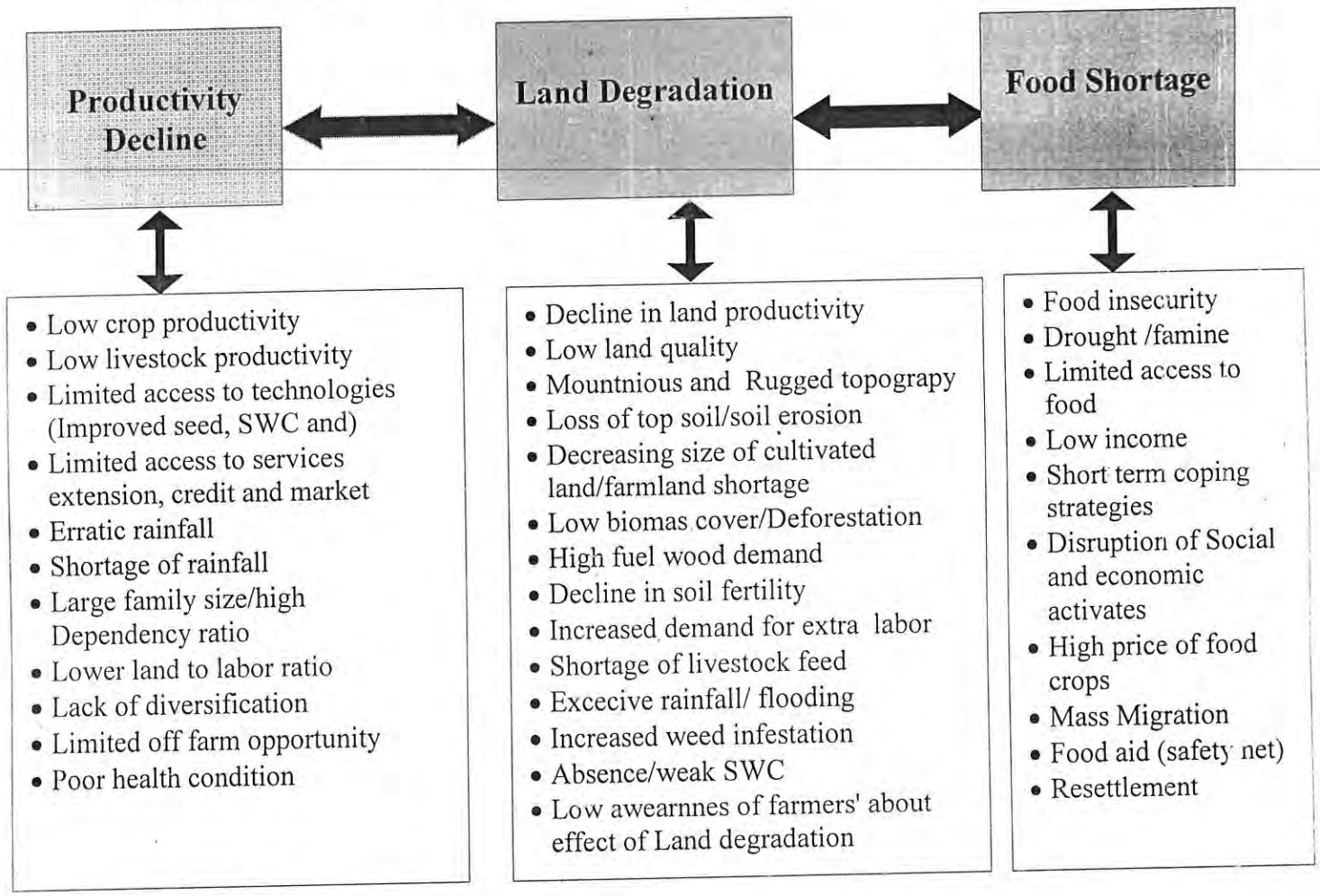
To summarize, food production and incomes of the people in the dry lands is low and in many places, conditions precipitated by low rainfall and concomitant productivity of the dry lands. There is therefore, high dependence on natural resources for survival. The pressure on these resources is growing against a background of declining capacity of the resources to sustain them. Therefore, increase in food production is critical for achieving food security for the growing population. However, degradation and declining productivity of soils, due to different interrelated and interwoven factors, poses a serious threat to agricultural production in many areas and land productivity being a key determinant of food security; mitigation of degradation process and restoration of soil productivity through various measures has to be a priority concern to achieve food security (Slaymaker, 2002).

2.4 Conceptual framework of the study

This section presents the conceptual nature of linkages between food shortage (food insecurity) and land degradation based on the preceding theoretical literature discussions. Hence, particular emphasis is given to the consequences and associations of land degradation, food shortage and agricultural production decline with their respective interfaces. It also includes awareness (knowledge) gaps among farmers to

the effect of land degradation on household food production. In line with this, a conceptual framework is developed as a guiding tool to better understanding of land degradation and food shortage nexus in the study area (see Figure 1)

Figure 1 Conceptual framework of the study



Source: Own formulation, 2008

Degradation of the resource base on which households' food production and livelihood depends has negative effect on food security (Smith and Hamilton, 2001). Thus, in the study area land degradation invariably means reduced household production or income, and hence directly affect the availability and access to food. Sekota *Woreda* has not been food self -sufficient since the 1973/74 famine and faced famines in 1984/85 and 1993/94 (SERA, 2001).

On the whole, in the study area the problem of food shortage is associated with land degradation, population pressure, a low level of technology and poor institutional services. These factors often interact with one another and bring a downward spiral of declining productivity, environmental degradation and food insecurity. The net result is a re-enforcing linkage that is trapping more and more households into the state of food insecurity and degradation of natural resources (Gete, 2000).

2.5 Empirical Studies on the determinants of Food security

Studies on analysis of determinants of food security at household level focus on personal attributes and household characteristics, social, institutional and natural environment. All of these factors are highly interwoven. The body of literature dealing with these factors is too vast to be investigated. In view of this, a few empirical studies are reviewed giving due emphasis to studies done in the country to show the salient issues determining households food security status.

Age of household head is one of the demographic variables that have an important bearing on household's food security status. The older the household head, the more experience he gain in farming. Moreover, older farmers are more risk averters, and mostly intensify and diversify their production activities. As a result, the chance for such household to be food secure is high. Age of the household head was found to be a significant factor (Abebaw, 2003; Ayalew, 2003; Degefa, 2002).

Studies reveled that sex of the household head is an important demographic variable that has influence on household food security. Women headed households need a long adjustment period to diversify their income sources fully and become food secure (Christina *et al.*, 2001). Due to the lack of labor in female headed households, they are

forced to rent their land as a share crop. Hence, male headed households are in a better position to pull labor force than the female headed ones. Moreover, with regard to farming experience and access to technology males are better than female farmers.

As agriculture is a dynamic occupation, agricultural production technologies are always coming up with better knowledge. Education equips individuals with the necessary knowledge of how to make use of these technologies and the ambition to get information and using it also increases. In Ethiopia context, recent studies in different parts of the country found that education status of the household head has significant effect on food security status (Abebaw, 2003; Million and Belay, 2004)

Household assets are important indicators of food security status. Total labor, size of cultivated land and livestock has important implications on households' food security status. Labour is one of the factors of production. Family labour plays an important role, particularly in rural families. Household with more agricultural labour results in more production and hence more income if enough land is available to accommodate the available labour. Increase in the availability of labour has positive influence in terms of increasing production and have positive contribution to household food security (Mulugeta, 2002).Similar to total labour, the ratio of total number of inactive labor force (less than 14 and above 64 years old) to the active labor force (between 15 and 65 years old) within a household was found to discriminate between food secure and food insecure households. A household with more inactive labor compare to the active labor group shows a high dependency ratio and the vice versa holds true. Empirical study in Ethiopia reported a negative and significant effect of dependency ratio on household's food security status (Genene, 2006).

One of the household assets, size of cultivated land, is one of the crucial household variables with respect to food security. This is because; the total size of cultivated land is important resource for food production and also one of the major sources of income in the household. As the cultivated land size increases, provided other associated production factors remain normal, the likelihood that the holder gets more output is high and this fact was confirmed by studies (Tesfaye, 2003; Workneh, 2006; Tesfaye, 2005)

Livestock are another farmers' important source of wealth as farmers accumulate wealth in terms of livestock. Livestock production constitutes a very important component of agricultural economy, a contribution that goes beyond direct food production to include multipurpose uses such as skins, fiber, fertilizer and fuel, as well as capital accumulation. Furthermore, livestock are closely linked to the social and cultural lives of farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability (Sansoucy, 1995).During drought years, livestock, a major asset that can be easily liquidated, is more important in terms of implying better access to food. Besides, the contribution of livestock to food security can be related with income from sales of livestock and livestock products, which are often used for purchase of food grains. Based on empirical studies households who possess large livestock size a were found to be food secure (Genene, 2006; Mulugeta, 2002; Tilaye, 2004)

Farmers' involvement in off-farm generating activities and their subsequent food security status have mixed results. If the farming system is a mono cropping system

and farmers engage in off- farm income generating activities out of their main agricultural activities. Moreover, off- farm income is a means to have more cash that is available to livelihoods of farmers. It provides cash to buy food grains and non-food items required for household members. Off-farm income was found to have a positive effect on household's food security status (Tesfaye, 2005; Workneh, 2006; Yilma, 2005).On the contrary to the results of these studies, off- farm was found to have a negative effect (Abebaw, 2003) These studies argue that off-farm activities take labor away from agricultural activities and decrease conservation investments threatened food security status of households.

Farm attributes mainly physical conditions such as its slope, soil type, top soil depth, stoniness etc were found to have effect on status of household food security. As poor farmland quality aggravates the declining rate of land productivity and in turn affects the grain production and food security status of households (Yared, 1999; Yilma, 2005). Another farm attribute is fragmentation of farmland which is the result of land redistribution and high level of soil erosion.

One of the constraints of food security is a problem associated with the control of pests. Crop pest problem is an important biological factor limiting crop production and causing food shortage. In some studies, it was argued that farmers with problem of pest infestation are more likely to be food insecure than those who do not have this problem (Tesfay, 2005; Yilma 2005).

Biophysical factors and climate, agro-ecological, play an important role in status of food security (Getachew, 1995; Eshetu, 2000; Tesfaye, 2003). This variable stands for

climate expressed in terms of agro-ecological classification (i.e. *Woina Dega* and Dry *Woina Dega*). A farming system is a classification of agro-ecological zones where diversity in soil type, distribution of rainfall, and ability to grow diverse food crops is differentially distributed within the two agro-ecological zones.

Household's food security status is highly influenced by their perception on the effect of land degradation on food security. Farmers who are aware of the effect of land degradation on food security are more likely design strategies or take immediate measure such as adopting soil and water conservation technologies than those who are not aware of it. As a study in *Bilate* water shade by Genen (2006) revealed farmer's perception of land degradation problems had a positive contribution to their food security status.

The future of agricultural development and food security in Ethiopia depends on to what extent the production system moves away from heavy reliance of rain-fed system and the extent to which farming is integrated with sustainable soil conservation and fertility management. This is in a way that practicing modern soil conservation measures mitigate land degradation problem through minimizing soil erosion, which in turn increase crop production. The model result by (Genene, 2006) confirmed that practicing soil conservation measures significantly determine household food security status. In line with this finding, a research conducted on soil and water conservation in the Eastern Ethiopia highlands at Hunde-Lafto area by Wagayehu (2005) concluded that investing in soil and water conservation (SWC) measures have positive impacts in terms of mitigating land degradation and improve farm household's food production and income. Likewise, fertility management

practices that enhance land productivity have a positive effect on household's food security status (Tesfaye, 2005; Mulugeta, 2002)

Institutional factors can enhance or inhibit farmers' status of food security. These institutional factors include: access to extension, credit, and market. Extension is generally expected to show a positive impact on household's food security status. However, this view has been testified in few studies (Yilma, 2005; Mulugeta, 2002) .Similarly proximity to market centers creates access to additional income by providing off-farm/non-farm employment opportunities, easy access to inputs and transportation. Households with access to market center were found food secured than who do not have easy access to market centers (Abebaw, 2003)

Among the institutional factors is credit service has also a profound effect on households food security status. Credit is an important source of investment. Those households who acquire credit service have better possibilities to invest either in agricultural inputs or livestock. The explanation is that those households who were willing to participate in credit scheme became capable of improving their income positions by performing different activities. Hence, there is a positive association between credit and food security status (Aabebaw, 2003; Tesfaye 2005).

In summary, various studies were reviewed and different socio-economic and bio-physical factors that were reported to have influence on household food security status in different localities of the country were identified. The review made so far is found to be quite useful and relevant to this study in that it helps to have a clear understanding about the hypothesized variables.

3. METHODOLOGY

This section briefly discusses the research methodology used in the study. It provides detail description of the analytical framework, data sources and method of data collection. Subsequently, it outlines the sampling procedure and techniques employed in the study. Finally, it presents the method of data analysis.

3.1 Analytical framework

Several studies indicate that the state of food security is influenced by an interwoven and interacting set of biophysical, demographic, socioeconomic and other household characteristics of the farmer's operational environment. Therefore, an appropriate analytical framework accommodating all these dimensions is required to come up with feasible and relevant outcomes.

To this effect, this section explains the analytical framework used to analyze the linkages between land degradation, agricultural production and food security. In varied literature the effects of land degradation focus on selected measures of productivity, but land degradation may also affect food security, through its impacts on food production as well as on incomes and food prices. It is suggested that constraints on land area and quality play an increasingly important role in determining food security.

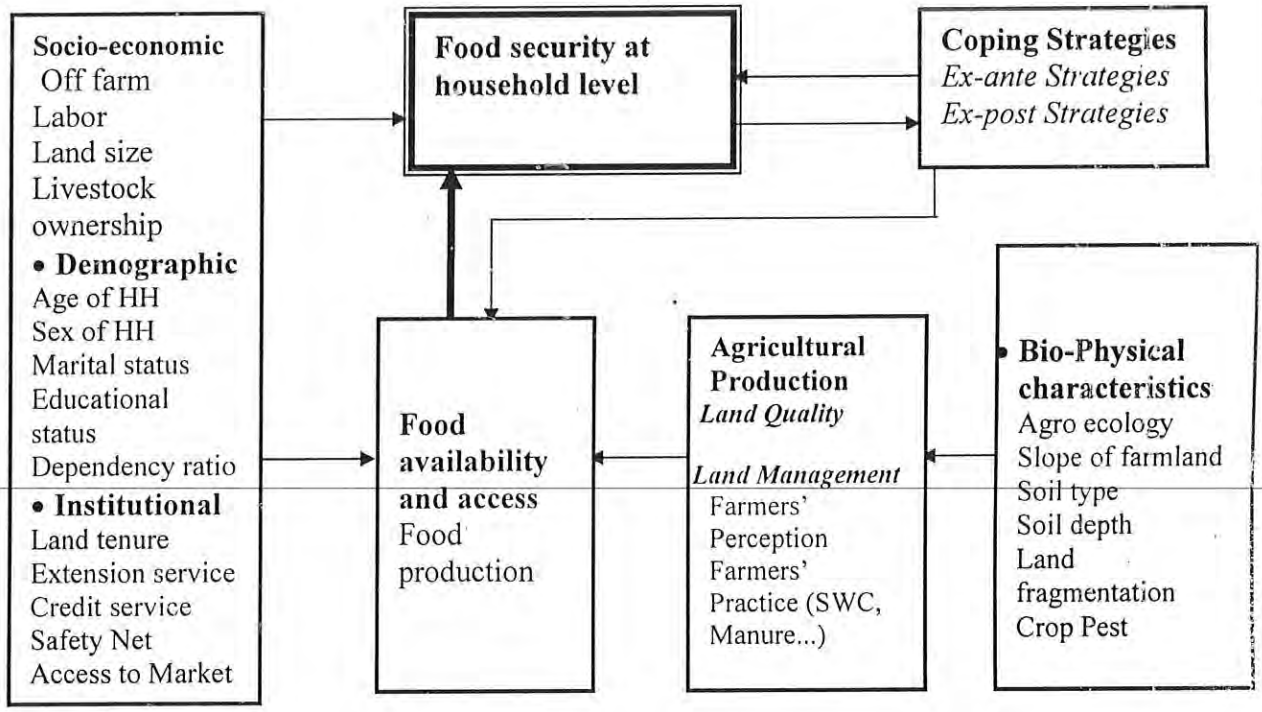


Figure 2 Analytical framework of the study

Source: Own formulation

Due consideration on farmers' choices with regard to production and conservation practices is essential to increase understanding on the relationship between land degradation and food security. It is also important to note that the linkage between food security and land degradation is captured through reduced production (and thus availability), but reduced productivity also affects food security by reducing the income (and thus access to food) of households that depend on agriculture for their livelihoods. Moreover, the complex and interrelated socioeconomic and bio-physical variables that are expected to determine food security at household level are explained in the hypothesis section

3.2. Data source and Method of data collection

3.2.1. Type and Source of Data

Both Qualitative and Quantitative data type were employed for the study from both primary and secondary sources. For the purpose of the study primary data was collected from 138 sample households, focus group discussion participants and selected key informants.

Primary data collected from sample households includes information on: households demographic characteristics (education, age, family size, sex, martial status), livestock holdings, bio-physical characteristics (Agro-ecology, land size, number of plots, slope and soil fertility status), institutional factors (accessibility of credit, agricultural extension and training services, market facility and land tenure), land management and perception (soil erosion severity, soil conservation practices, perceptions of land degradation) and causes of food shortage.

Secondary data were collected from both published and unpublished documents, which include information about population, age structure, land use pattern, farming systems, infrastructure situation, crop production trend, meteorological data (annual rainfall and min-max temperature), etc. The secondary data was collected from Zonal and *Woreda* office of Agriculture and Rural Development, Sekota Dry-land Agricultural Research Center (SDARC) and Save the children UK.

3.2.2. Method of Data Collection

In view of the complexity of the problems of food shortage and land degradation, the nature of information needed on various aspects of this research, a single method of data collection is impossible to satisfy the data requirements. Therefore, a combination of formal and informal method data collection techniques are employed to generate adequate and reliable data.

Household survey: To generate information at household level, formal survey was undertaken using structured questionnaire. Before embarking the formal survey (i.e. interview), pre-testing of the interview schedule was carried out and accordingly revision was made and finalized. Ten enumerators were recruited based on their proficiency in communicating using local language, educational background and prior exposure to similar works. Training was given to enumerators on the content of the schedule and procedures to follow while conducting the interview.

Focus group discussion: A total of four focus group discussions were undertaken, this was conducted with a group composed of 7-9 male and female households, Kebeles officials, staffs of the *Woreda* Agriculture and Rural Development Office (WADO) and Sekota Dry Land Agricultural Research Center (SDARC) and other NGO staffs working in the area. The nature of the data includes the general features, trends and problem of land degradation and food shortage with respect to change in vegetation cover, land use pattern, soil erosion severity, and occurrence of drought and productivity decline.

3.3 Sampling Procedure

A two-stage sampling procedure was employed to draw sample household heads. In the first stage, out of the total thirty three kebeles in the *woreda* six kebeles namely Woleh, Hamusite, Tia, Serial, Tsemera and D/birhan were selected using random sampling method. However, inaccessible kebeles were first excluded in the course of kebeles selection. They were selected in close collaboration with *woreda* extension experts, where their accessibility and extent of food insecurity problem was considered. At the second stage, from the six kebeles, a total of 140 household heads were selected proportionately from the list of households in the respective kebeles. Given the relative inter household heterogeneity in terms of their demographic, socio-economic and biophysical characteristics, sample households were identified using simple random sampling technique. However, two sample households questionnaire were not completed properly, and hence only 138 sample households were included in the analysis.

Table 1 Total number sample households and Sample size

Woreda	**Total kebeles**	**Total households**	**No. of sample kebeles**	**Name of sample kebeles**	**Total households in sample kebeles**	**Sampled households**
Sekota	33	43,582	6	Tsemera	1,305	31
				Woleh	1,177	28
				Hamusite	1,117	26
				Serial	989	21
				Tia	741	19
				D/birhan	489	15
				Total	5818	140

Source: Computed on the basis of WADO, 2006

3.4 Method of Data Analysis

The examination of farmers' opinions and observations and statistical comparison of households with their characteristics of food security status is often quite complex. Following the completion of the data collection, the data was coded and entered into SPSS version 15.0 computer software program for analysis. The different analytical techniques include descriptive statistics (frequency, ratio, percentage, mean) and bivariate analysis. The t-test was used to see the existence of statistically significant difference in continuous variables of household characteristics of food secure and food insecure group. The chi-square test was run to see if there is any systematic association between food security status and some household characteristics. Moreover, Logit model of econometrics was employed to identify the determining factors of households food security in the area

3.4.1. Measuring Land degradation

Land quality index is taken as proxy variable for measuring land degradation at farm household level. Land quality index was computed using weighted parameters for different indicators of land quality. The indicators included are slope gradient, soil depth and severity of soil erosion of a given farmland at plot level. Each of the factors is believed to reflect the extent of land degradation in farmers' farm plots. Farmers allocated the total number of their plots to the different indicators with there respective levels, given a value of 1 for very high, 2 for high, 3 for moderate and 4 for low. Hence, a land quality index for each farm households developed by analyzing the total score of each factors with respective total number of plots.

Land Quality index is given as:

$$LQI_Y = \frac{\sum_{j=1}^{4} X_j}{V} \qquad \text{----------(1)}$$

Where,

LQI_Y indicate land quality index for the farmland Y

$X_j = 1, 2 \ldots 4$ variables used to determine the scale

V is number of indicative variables

3.4.2. Measuring Food security status

Food security status at the household level was measured using household kilo caloric acquisition method. Hence, dietary intake is used as a proxy to measure household food security status. Precaution was taken when the list of foods was prepared in the questionnaire to be detailed and exhaustive. Hence, prior to the survey time all the possible food type exclusively identified through informal survey with female household heads. Thus, household consume a variety of food, mainly from purchases that are converted into their calories using ENHRI (1998) food composition table, and hence households that exceeds 2100 cal per person per day are food secure and below food insecure.

4. DESCRIPTION OF THE STUDY AREA

4.1. Description of the study area

4.1.1. Geographic position and Location

Sekota *woreda* is located between 12^0 23′ and 13^0 16′ north longitudes and 38^0 44′ and 39^0 21′ east latitudes. It extends for about 98 km in the north south direction and 67 km in the east west direction. It has compact shape and an area of 3058 km^2 (SERA, 2001). The district is located in the eastern part of Wag Himra Administration Zone (WHAZ) of the Amhara National Regional State (ANRS). WHAZ, which is one of the11 administrative zones in ANRS, represents the Agaw ethnic group and comprises of 6 *Woredas* namely Sekota, Dehana, Gazgibla, Abergelle, Sihala and Ziquala. Sekota shares borders with Ziquala *Woreda* in the west, Dehana and Gazigibla *Woredas* in the south and southwest, Tigray National Regional State in the North and east, North Wollo Zone in the south. Sekota town, the capital of the zone, is 720 km North of Addis Ababa and 540 km north east of the regional state capital, Bahir Dar.

4.1.2 Population

The result of the 1994 population and housing census showed the total population of Sekota was 130,229 in the year 1994 and projected to reach 167,504 in the year 2006. (BOPaED, 2004). According to this projection it is expected that about 92% of the population lives in rural areas residing in 33 Kebeles and the remaining 7.2% in Sekota town with the total density of the rural population of 53.7 persons per square kilometer. Women constitute 49.9 % of the total population.

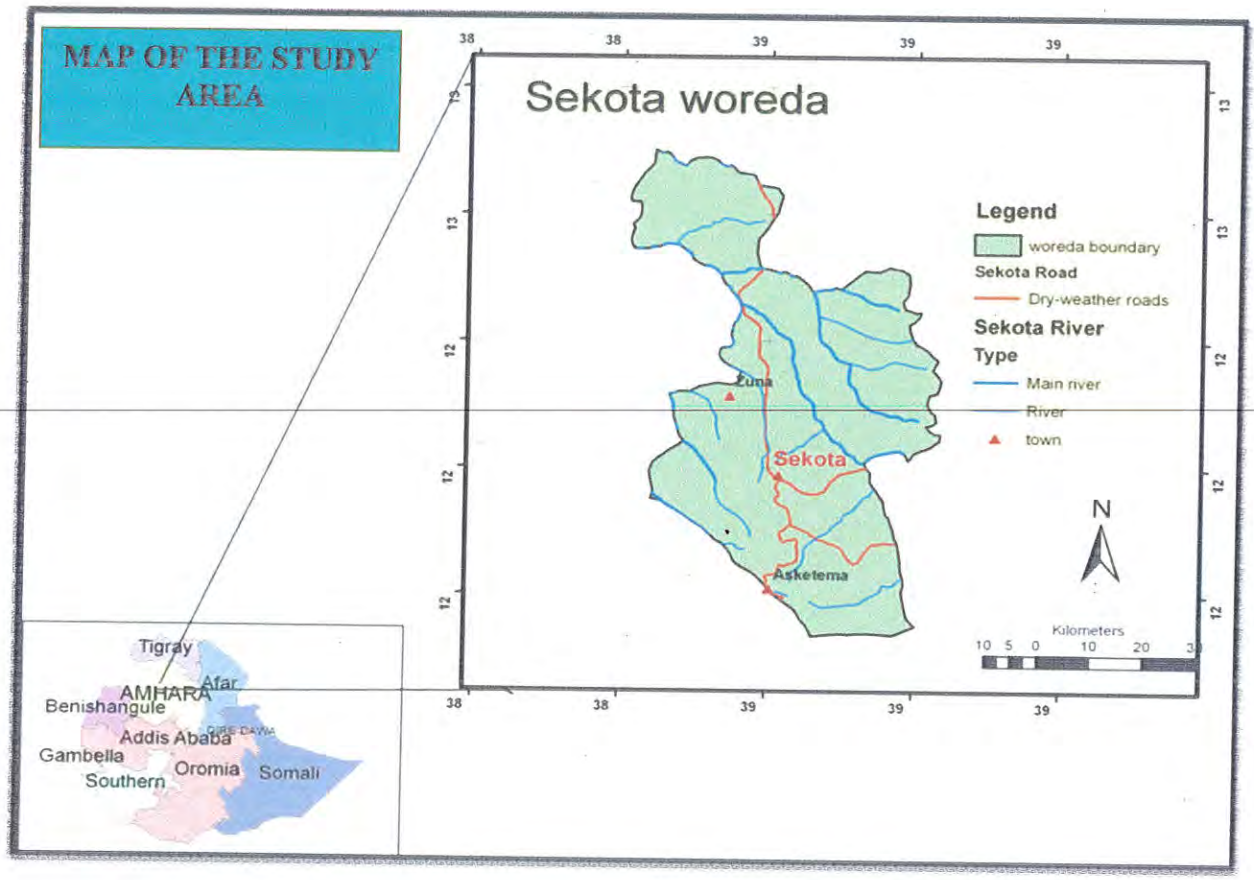


Figure 3 Map of the study area

Source: Own Construction using available data

The major ethnic group in the *Woreda* is Agaw, however about 52 % of the population speaks Amharic, 45% Agewegna *(Himtigna)* and 3% Tigregna. Orthodox Christianity is the dominant religion (99.5%) and other religions in the *Woreda* include Muslim (0.4 %), Protestant Christians (0.04 %) and some other religion (0.06%) (WADO, 2006). Agriculture is the major enterprise on which the livelihood of the rural population depends on. Only 0.5 % of the rural population collects its livelihood from non-agricultural activities like handicraft, trade and being hired as casual and daily laborer.

4.1.3. Topography and soil type

Undulated terrain marked the topography of the *Woreda*. The topography of the area consists of a chain of mountains, hills, valleys and cliffs that exposed the natural resource for severe degradation mainly due to erosion. The hills and cliffs are stony and rocky covered by very sparsely scattered vegetation. Valley bottom and plateau are suited to agriculture. Generally, flat land and land with gentle slope is scarce and comprises only 27% of the total area. Hilly topography covers about 36% of the area while valley, ups and downs and marshy area make up 2%, 34% and 1% of the *Woreda*, respectively (SERA, 2001).Regarding the soil type, red soil is the predominant soil type in the *Woreda* constituting 50.9%. The second most abundantly found soil type is gray soil (35.2%) followed by black soil (8.3%). The proportion of land with brown soil is only 5.6%.

4.1.4 Climate

The major environmental characters of the *Woreda* are given in Table 1. The *Woreda* includes areas with low elevation, Tekeze Valley, and peaks (Mount Bella) with elevation of about 3715 m.a.s.l. The mean annual rainfall of the *Woreda* ranges between 400 mm and 1386 mm. Thus, computed 30 years average rainfall data depicts that the woreda receives very minimal rainfall. (See Annex III). The *Woreda*, generally, has a higher annual evaporation amount than the precipitation it receives. Lack of sufficient rainfall for both crop and animal production is the major agricultural bottleneck of the *Woreda*. The area is characterized by sub moist major agro ecological zone with SM2 (tepid to cool sub moist mid highland) and SM1 (hot to warm sub moist lowland) (SERA, 2001).

Table 2 Background data on Climate of Sekota *Woreda*

Character	Lowest	Highest
Rainfall	400 mm	1386 mm
Evaporation	1044 mm	1798 mm
Mean max temp.	12.88 °C	32.92 °C
Mean min temp	-1.11 °C	16.76 °C
Absolute max tem	15 °C	36 °C
Absolute min tem	-3.0 °C	13.8 °C
Elevation	1086 m.a.s.l	3715 m.a.s.l

Source: WADO, 2006

4.1.5. Land use and farming system

Sekota *Woreda* has a total area of 305,771 ha. From this area, only 16.02 % is used for crop production. About 36.4 % of the *Woreda* is non-usable at present. Area covered by bush constitutes 37.8% while only 0.01 % is under forest cover. Area allotted for grazing and road construction has 3.2% and 6.5% proportion shared from the total area, respectively (WADO, 2006).

The dominance of crop to livestock in the farming system varies based on the agro-climatic zone. The mid altitude areas are dominated by crop cultivation. In the lowlands livestock rearing is an important enterprise as to crop production. Farmers in the mid-altitude area grow many crops including cereals, pulses, oilseeds, fruit and horticultural crops. However the major crops in terms of both area and production in the *woreda* for are teff, barley, sorghum, wheat, fababean, filed pea and sesame. Source of draft power is a critical problem to the area. Hence about 19% of the farmers produce crop by hoe culture. The crop production is totally dependent on traditional farming practices and farm implements. Irrigation agriculture constitutes a very small fraction (1.3%) out of the total area on which crop is produced.

There are about 251,591 head of livestock and 80,204 poultry. Of the livestock population number of cattle constitutes 39.12%. The remaining heads of livestock are composed of goats (36.15%), sheep (18.9%), donkeys (5.2%), mules (0.6%) and horses (0.03 %). Bee keeping and poultry is an integral part of the animal husbandry in the study area, both are mainly practiced under traditional system, and the level of their productivity is very low (WADO, 2006).

4.1.6. Infrastructural facilities

Water and energy sources: The main sources of water for drinking and other purposes are rainfall, rivers and springs. In the *Woreda*, there are about 25 rivers of which majority are perennial and have a potential of irrigating about 1,021 hectares of land (WADO, 2006).

However, ironically, only about 13,902 (8.3 %) out of the total of 167,504 people of the *Woreda* have access to potable water. The remaining population gets its water requirement from spring, dug wells, collected run-off and rivers in the proportion of 75, 9.5, 5.0, and 2.2 per cent respectively (WADO, 2006).

Transport and Communication: Due to the emphasis given by the present government, within the last decade, about 515-km all-weather roads were constructed which connect Sekota town with Tigray, Northern Wollo and the two *Woredas* of the zone (Zikuala and Dehana) and acquired access to a semi-automatic telephone service. However, the telephone services are not extended to the other small towns of the *Woreda*.

Education and Health Service: According to the 1994 census (CSA, 2004), the illiteracy rate of the total population was as high as 94.8 % and in the rural areas it was even more (96.0%). However, government and NGOs have built about 24 elementary and junior secondary schools since 1992. Before that there were only seven elementary and one high school in the study area.

The health facilities are not much different from what is seen in education. For the entire Waghimera zone, there is only one hospital with 20 beds, one health center, eight clinics and four health posts. However, more than the infrastructure skilled manpower and lack of equipment limit the utilization of the existing facility to its full capacity (WADO, 2006).

4.2 Food Security Status of the Household

This study measured household food security in terms of the adequacy of daily kcal consumption per adult equivalent of each household. Sampled households reported that over 10 food items were used for consumption during the last 14 days prior to the survey period. The most commonly eaten foods items are made of mostly from cereals that include teff, sorghum, barley, wheat and field pea. To some extent farm households also consume food items made of pulses such as safflower, noug, sesame, linseed, livestock products (butter, milk and honey) and vegetables.

For the purpose of this study, the concept of food security is defined as the extent to which total household energy consumption per day to meets its subsistence requirement. Accordingly, household consume a variety of food, mainly from purchases that are converted in to their calories using ENHRI (1998) food

composition table, and thus, those households beyond the minimum recommended caloric requirement level (≥ 2100 cal per person per day) were deemed to be food secured, henceforth the term food secure referred to those households) and otherwise food insecure.

Table 3 Distribution of Sample Households per capita kilocalorie available

Kilo calorie per person per day	N	%
601-1100	38	27.5
1101-1600	33	23.9
1601-2100	24	17.4
2101-2600	16	11.6
2601-3100	15	10.9
3101-3601	12	8.7
Total	138	100

Source: Own survey, 2008

Likewise, the results of this computation revealed in Table 3 depicts that the energy consumption of households in the study area ranges from 600 to 3600 Kcalorie, this indicated that there is a huge gap Kcalorie per person per day level among the sampled household. Regarding the status of households based on their food security level, 68.8% of the sample households were found food insecure while 31.2% of the sample households food secure.

5. RESULT AND DISCUSSION

This Chapter, which is divided into three major sections, bring to light the major findings of this study. In the first section demographic, socioeconomic, biophysical and institutional characteristics of the total sample households (n=138) and their relationship to household's food security status is presented using descriptive and bivariate analysis. The total sample households are thus categorized into two groups, as food secure households (n=43) and food insecure households (n=95).The former makes 31.2% while the later 68.8% of the total sample households, respectively. The second section provides results of analysis on the linkage between land degradation and household's food security status using both qualitative and quantitative data, so as to provide better understanding on the interaction between land degradation and food security status in the study area. The third section illustrates the perceive causes of food shortage and households coping strategies in the area.

5.1 Demographic, Socio-economic and Farm Characteristics

5.1.1 Demographic Characteristics

5.1.1.1 Sex and Marital status

Majority of the sample household (87.7%) were male headed households while the remaining 12.3% of the respondents were female headed households. In the study area like other northern parts of Ethiopia, there is a cultural barrier towards female involvement in farming activities such as plowing. Thus, female-headed households who have lesser available active labor are obliging them to engage in sharecropping arrangement, which in turn substantially decrease their production. Therefore, the result of food security status by the sex of the household head indicated that among all

food secure households 90.7% belong to male headed households while the remaining 9.3% were female headed. On the other hand, among all food insecure households 86.3% were male- headed, while the remaining 13.7% were female-headed households. Thus, percentage figures for female households reveal larger tendency to food insecurity (13.7%) than food security (i.e. 9.7%) (See Table 4 overleaf). However, the chi square test showed no significant association between household head sex and food security status.

Regarding the marital status of the households, about 75.4% of sample households were married while 21.1% and 3.6% were divorced and widowed, respectively. Similar to the sex of household heads, there is no significant association between marital status of the households and food security status.

5.1.1.2. Age and Educational Status

Table 4 overleaf, presents the mean age of sample household heads, by food security status. The mean age of food secure households is 41.7 years while the figure for food insecure households is 39.05 years. The statistical analysis by t-test revealed that mean difference in age between food secure versus food insecure households is significant at 5% significance level. This shows as age of the household head increases the likelihood of being food secure increases. This is probably due to the fact that when age increases through experience, the capacity to avert risk and possibility of possessing higher productive assets (i.e. farmland and livestock) also increases and thus the tendency of being food secure increases.

An educated farmer is able to use modern agricultural technologies, perform farming activities based on cropping calendar and manage resources properly. All these factors

boost production and improve availability and accessibility of enough food. The survey result showed that, 42.8% of the sample household heads were literate, while 57.2% were illiterate. The survey result indicated that food secure households (46.5 %) are more literate than food insecure households (41.1%). However, chi-square result revealed no systematic association between educational status and food security status of the sampled household heads.

Table 4 Summary of Demographic characteristics of Sample households

	Status of Food security						$\chi 2$ Statistics
	Food insecure		Food secure		Total		
	N	%	N	%	N	%	
Sex of the household head							
Male	82	86.3	39	90.7	121	87.7	
Female	13	13.7	4	9.3	17	12.3	**0.526(NS)**
Marital Status of household head							
Married	69	72.6	35	81.4	104	75.4	
Divorced	23	24.2	6	14.0	29	21.1	
Widowed	3	3.2	2	4.7	5	3.6	**1.966(NS)**
Educational status							
Illiterate	56	58.9	23	53.5	79	57.2	
Read and Write	23	24.3	7	16.3	30	21.7	
Primary Education	16	16.8	12	27.9	28	20.3	
Secondary Education	0	0	1	2.3	1	0.7	**2.111(NS)**
Educational status by category							
Illiterate	56	58.9	23	53.5	79	57.2	
Literate	39	41.1	20	46.5	59	42.8	**0.360(NS)**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**t-statistics**
Dependency ratio	1.57	0.9114	1.25	1.033	1.47	1.004	-1.690*
Age of the Household Head	37.83	9.342	41.74	10.501	39.05	9.849	2.191**
Household Size	5.47	1.878	5.14	2.007	5.37	1.918	-.947(NS)

Source: Own survey, 2008
Note: * Significant at 10%, ** Significant at 5 %, * Significant at 1%**
NS: Not Significant

5.1.1.3. Household size and Dependency ratio

The mean size of the sample households was 5.37 persons which is above the national average family size of 4.9 persons per household (CSA, 2001). The mean household

size of food insecure and secure households was 5.47 and 5.14 persons with standard deviation of 1.87 and 2.00 persons, respectively (See Table 4 above). There exist a slight difference in mean household size of the food insecure and food secure household as the former group has a relatively larger mean size of households than the later. Nevertheless, the t-test result showed that there is no significant difference between the mean household sizes of the two groups. These averages may mask important differences among households with respect to food security, as it only consider the sheer size of households. So, further investigation with regard to age compositions of the household members is important to uncover its influence on food security.

According to CSA (2001), the national dependency ratio was 101 implying that every 100 persons which are in economically productive age group have to support additional 101 economic inactive persons. The mean dependency ratio of sample households was 147 with standard deviation of 100.4. The mean dependency ratio for food insecure and secure households was found to be 157 and 125 with standard deviation of 91.14 and 103 respectively (See Table 4). The food insecure sample households have quite lager number of economically inactive family member as compared to the food secure sample households. The t-test result revealed significant mean difference between the two groups at 1% significance level. This means the larger the number of economically inactive family members in a household, the more household is becomes food insecure than food secure. In other words, family members in age range of 15-64 years have to support not only themselves, but also additional dependent members in the family, which increase the need for food and other basic necessities in the household. This is particularly true in a dry land

environment (i.e. with unpredictable rainfall pattern) where intensive labor is required to perform most of the agricultural activities in time.

5.1.2 Socio-economic and Farm characteristics

5.1.2.1. Labor availability and off-farm Activity

In the study area, labor is an important resource in the farming community. Farmers mainly depend on family labor for their farm activities and social purposes. The total size of labor is computed by converting the available labor in the household into man equivalent index (See Annex i). The mean total labor in man equivalent of the sample households was found 2.39 with standard deviation of 0.86. The mean labor of food insecure and food secure households was 2.36 and 2.46 with standard deviation of 0.85 and 0.89, respectively. The result indicates that food secure households have relatively more family labor than food insecure ones. Moreover, the statistical analysis by t-test showed significant mean difference between food secure and insecure groups in their total labor size at 10 % significant level (See Table 5).

Although farmers in the *woreda* have land shortage and cultivate small holdings, they face labor shortage for some critical farm activities. These critical seasons / activities include, weeding, harvesting and pilling of crops. Out of the total sample households, 60.9% reported shortage of labor to perform farming activity. Of these, 64.2% and 53.5% were from food insecure and food secure groups respectively. It seems on surface that, food insecure households experience more labor shortage for farm activities than food secure. However, the result of chi-square result revealed no systematic association between labor shortage problem for farm activities and food security status of the sampled household heads.

To tackle this problem of labor shortage farmers in the area have evolved an age-old labor sharing arrangements which is also common in other parts of the country. Thus, the popular way of overcoming labor shortage, especially for the major labor demanding agricultural tasks, is the use of the traditional mutual labor exchange arrangements as reported by majority of the sampled households (77.1%) namely *Lifint/Debayt and Wobera*,

Lifint/Debayt is a reciprocal labor sharing arrangements where farmers help each other at times of peak labor demanding seasons among farmers with smaller land holdings. *Wobera*, on the other hand, is an arrangement, which is practiced mostly by 'rich' and 'middle' class farmers who rent in others crop land and cultivate more than the average land holding, in which the host farmer is expected to serve foods and drinks for the assisting farmers. In this case reciprocity is not expected. Conversely, farmers who are unable to cultivate their land, mainly, due to the lack of oxen or seed shortage or landlessness, are employed as casual laborers for labor demanding farming activities. Most female headed and few 'rich' households are engage in use of this arrangement. The wage for labor varies between 4 to 10 birr per day depending on the season. In bad season, when there is drought and food shortage, wage goes as low as three birr per day and goes up in good seasons. Likewise, 15.5% of sample households hired laborers to tackle their labor shortage. It makes 16.4% of food insecure and 13% of food secure households (See Table 5 overleaf).

Table 5 Summary of Socio-economic and Farm characteristics

	Status of HH food security				Total		$\chi 2$ Statistics
	Food insecure		Food secure				
	N	%	N	%	N	%	
Do you face any labor shortage last year for your farm activity?							
No	34	35.8	20	46.5	54	39.1	
Yes	61	64.2	23	53.5	84	60.9	
Total	94	100	43	100	138	100	1.429(NS)
Mechanisms used for solving labor shortage problem?							
Hired labor	10	16.4	3	13	13	15.5	
Traditional labor arrangement	46	75.4	17	73.9	64	77.1	
Both	1	1.6	1	4.3	2	2.4	
None	4	6.6	2	8.8	6	5.0	2.050(NS)
Do you involve in off farm activity?							
No	68	71.6	37	86.0	105	76.1	
Yes	27	28.4	6	14.0	33	23.9	0.022*
Land size (ha) Category							
Landless	17	17.9	8	18.6	25	18.1	
0.1-0.5	21	22.1	5	11.6	26	18.8	
0.51-1	31	32.6	13	30.2	44	31.9	
1.1-1.5	10	10.5	5	11.6	15	10.9	
1.5-2	6	6.3	5	11.6	11	8	
Grater than 2.01	10	10.5	7	16.3	17	12.3	3.606(NS)
Total number of farm plots categories							
1-2	47	49.5	12	27.9	59	42.8	
3-4	34	35.8	18	41.9	52	37.7	
5-6	11	11.6	10	23.3	21	15.2	
7-8	2	2.1	3	7	5	3.6	
>9	1	1.1	0	0	1	0.7	8.554*
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**t-Statistics**
Total Household labor	2.36	0.858	2.46	0.892	2.39	0.8669	0.616*

Source: Own survey, 2008
Note: * Significant at 10%, NS: Not Significant

Off-farm income generation activities: In the study area, the most common off-farm activities are petty trade, employment as a daily laborer in near by towns and preparing local foods and drinks and few craft works. Due to very limited nature of income and return from these activities, most farmers do not consider off-farm income as a primary income source. Therefore, it has a supplementary role. The scope to diversify their cash income through employment in off-farm or non-farm activities appears very limited. According to the survey result, out of the total sample household heads, only 23.9% reported involvement in off farm income generating activities.

More food insecure households (28.4%) were found to engage in off-farm activities than food secure (14.0%) households, which clearly showed the existence of fewer opportunities and a near negligible contribution of income from those activities to food security.

5.1.2.2. Land size and Ownership

Owing to dry-land nature and rugged terrain of the *woreda*, land is a very critical resource to households. Farmland possession means a lot to the rural livelihoods in *Sekota*. Farmers who own farmland are richer, in relative terms, than those who do not. As land is a public property owned by the state, farmers have only usufructuary right to the plots of farmland they are entitled to. There are a large number of farmers who own no farmland at all to till and some with very small plots.

As indicated in Table 5 above, landless farmers and farmers owning less than or equal to 0.5 ha of farmland make up 18.1% and 18.8% of the sample households, respectively. The majority of landless farmers in the area are young (i.e. those in age group between 21 and 41 years), as no redistribution was made after 1993. Thus, it is very difficult for younger farmers to establish house and begin proper marriage life as a separate economic as well as domestic unit, given that it absolutely demands access to land. Thus, young farmers are presently the major victims of land-less- ness.

The size of farmland owned per household has been shrinking for so long due to the ever-increasing human population and the severe problem of land degradation in the farmland which has transformed most of the farmland in area unfit for cultivation. On top of this, further expansion of the farmland is not possible as the potential is limited by the rugged nature of the local topography. Out of the sample households 31.9%,

have land size of 0.5 - 1 hectares. Majority of the sample households (68.8%) were found to have land size less than one hectare, which is even less than the average land holding of the study area. This clearly shows that larger proportion of the sample households own small landholding less than the national average of 0.9 ha, upon which their food security and other necessities must be obtained. About 10.9% of the sample households were entitled to have land size in range 1-1.5 hectares. Only 20% of the sample households were found to have more than 1.5 hectares (See Table 5). The mean land size of owned by the sample households was 1.06 hectares.

The survey result presented, in Table 5, show the mean land holding of total sample households by food security status of household's. Thus, the mean land holding of food insecure and food secure households was 0.99 and 1.24 hectare, respectively. The t-test result showed no significant mean difference between food-secure and insecure households.

On the other hand, the mean cultivated land of total sample households was 2.02 hectares, while the figure for food insecure and food secure households was found to be 1.82 and 2.47 ha per household, respectively (See Table 6 overleaf). The statistical analysis showed that there is a significant difference in size of cultivated land between food insecure versus food secure households at 5% significance level. This indicates households with larger cultivated land had more access to enough food and became food secure. This is probably due to the fact that, in the study area use of inputs like chemical fertilizer and improved seeds is very limited. Therefore, the option taken by food secure households was to increase production by increasing area of cultivated land through either inheritance or renting and in some cases sharecropping.

The mean rented in land size of the sampled households was 0.97 ha. The figure for food insecure and food secure households was found to be 0.85 and 1.23 ha per household. As indicated earlier, there is no significant mean difference in land size holding between the two groups, but there is significant difference in size of land rented in between food insecure and food secured households at 10% significant level, which contributed to significant mean difference in size of cultivated land of food secure and food insecure households.

Table 6 Summary of Farmland characteristics of sample households

	Food Security Status HH				Total		
	Food insecure		Food secure				
	Mean	SD	Mean	SD	M	SD	t-Statistics
Size of cultivated land	1.82	1.285	2.47	1.693	2.0230	1.45139	2.521**
Size of owned land	0.9866	0.9854	1.2430	1.1353	1.066	1.037	1.349(NS)
Size of rent in land	0.8526	1.0458	1.232	1.3533	0.9710	1.158	1.798*
Total number of plots	2.94	1.835	3.79	1.712	3.21	1.834	2.553**
Land Quality Index	8.84	5.752	10.96	5.613	9.509	5.773	2.020**

Source: Own survey, 2008
Note: * Significant at 10 %, ** Significant at 5 %, NS- Not Significant

5.1.2.3. Farmland fragmentation

Due to shortage of adequate cropland with similar fertility level, having land at more than one place is not an exception but it is rather a norm. Added to this, their land holding is scattered in more than two places to create equitable share of the relatively `better' land during the land redistribution in 1993.

It was noted during the focus group discussion that, in the study area land fragmentation is perceived by farmers both as an advantage and a problem. The positive side, from their view point, is that it provides a good opportunity to produce different crops on different soil types and fertility status which can be considered as risk aversion strategy during crop failure. On the contrary, the negative side is that, it

demands extra labor to look-over the crops, protect from wild animals and transport implements and produces from and to the plots. However, most farmers consider it as an inevitable and desirable system to create equitable farmland distribution.

In the same token, the field survey data reveal a substantial difference with respect to the total number of farm plots that sample households own. The total number of farm plots that sample households owned was found to range from 1 to 13 plots. Majority of the sample households (42.8%) reported they have one or two farm plots. The remaining 37.7%, 15.2% and 4.3% of sample households own 3-4, 5-6 and more than7 plots respectively. (See Table 5)

Furthermore, the mean number of farm plots for food insecure and secure households was found to be 2.94 and 3.79, respectively with significant mean difference between the two groups at 5% significant level. This entails that households with higher number of farm plots tend to be food secure. The probability of having more number of plots is related to an increased size of total cultivated land through inheritance or renting, which provides a good opportunity for farm households to produce more both in amount and variety of crops. (See Table 6)

5.1.2.4. Farmland Quality

Having access to quality land is a critical input for both crop and livestock production. On the contrary, poor land quality leads to lower yield which necessitate decline in food production by the household. Hence, quality of farmland is an important farm characteristic which determine household food security status. In this study, quality of farmland is assessed based on farmers' own judgmental decisions to different weighted attributes of land quality index and it is considered as a proxy variable to

measure the extent of land degradation on farm plots. Selection of indicators to land quality index was made based on perspective of the local farmers' to a better farm-land. The indicators included are slope variation, soil depth difference and severity of soil erosion on a given farmland at plot level that provides the extent of soil erosion problem on farm plots. Therefore, households with high land quality index are assumed to have better farmland quality.

Table 6 illustrates the result of land quality index for the sample households. Accordingly, the mean land quality index was found to be 9.5 with standard deviation of 5.77. The mean farmland quality index for food insecure and secure households was found to be 8.84 and 10.96 with standard deviation of 5.75 and 5.61, respectively. The t-test result revealed that, there exists a significant mean difference at 5% significance level between the two groups. This result was in agreement with the expectation that higher land quality index has a positive impact to household food security status. Thus, household with higher land quality index are likely to be more food secure than households with low land quality index.

5.1.2.5. Livestock ownership

In the study area, where crop production is unreliable occupation, livestock make momentous bestowal to the livelihoods of farmers and is a source of self-reliance against income shocks. Livestock species that are generally kept to make-up the livestock resources in Sekota *woreda* include cattle, goats, sheep, donkeys and mules. Bees and poultry are also other enterprises practiced very widely in the area. Livestock are maintained in the study area for draught, milk, meat, egg, and mainly for sale purposes. They are also considered as a productive asset for the household.

Farmers conventionally refer to their livestock as *Genzeb*, reflecting a high value set attached to livestock holding in the local area.

The average numbers of livestock holding between the two groups of sampled households is different. In order to make comparison of the herd size between the sample groups, the herd size was converted into livestock units (LU) based on Storck *et al.* (1991), (see Appendix ii). Moreover, diversification of livestock holding is the prime strategy in all the cases where farmers traditionally practice to minimize the risk of vulnerability to recurrent drought that occurs in the area. Keeping various livestock species at a time, serves as a good buffering strategy to cope up crop failure that occurs very repeatedly in the area. Hence, the mean herd size (excluding oxen) in Total livestock Unit (TLU) for the food secure households (4.08) was greater than that of the food insecure households (i.e. 2.76) and the independent sample t-test for the mean difference was significant at 1% probability level (see Table 7).

Table 7 Livestock ownership by sampled household farmers

Livestock ownership in TLU	Status of HH food security				t-statistics
	Food insecure		Food secure		
	Mean	S.D	Mean	S.D	
Oxen	1.831	0.807	2.209	0.832	0.947*
Cows	0.810	0.903	1.070	1.183	1.414(NS)
Heifers	0.1421	0.35101	0.2442	0.45476	1.439(NS)
Bull	0.0316	0.24255	0.1221	0.43085	1.573(NS)
Calves	0.1079	0.16572	0.1744	0.22184	1.958(NS)
Goats	0.4535	0.51764	0.6835	0.92836	1.863**
Sheep	0.0575	0.18455	0.0967	0.21247	1.104(NS)
Donkeys	0.2947	0.49581	0.4558	0.58931	1.665*
Mules	0.0000	0.00000	0.2116	0.97253	2.130**
Hens	0.0439	0.06705	0.0466	0.05640	0.224(NS)
Total (excluding oxen)	2.7682	2.27818	4.0813	4.01083	2.6586***

Source: Own survey, 2008
Note: * Significant at 10%, ** Significant at 5 %, * Significant at 1%**
NS: Not Significant

As the report from the WADO (2006) indicates, small ruminants especially goats, comprises the largest herd size in the area. Besides, sheep and goats are very commonly bred to serve as milk sources and to be sold for cash need especially in desperate times of drought and food shortage. Thus, as the t test result revealed, there is a significant difference in mean herd size of goat in livestock unit between food secure and insecure households (0.68 and 0.45 respectively).

Food secure households apparently own relatively high numbers of pack animals than food insecure households as indicated in the above Table 7. Besides, the t-statistical analysis revealed that, there exists significant difference, at 5% significant level, between the two groups. Mules which are considered as wealth indicator in the area generally play a very crucial role in provision of transportation services on the steep slopes and mountains dominated terrain. Donkeys and mules are also used for trading activities and in some cases for plowing croplands.

Oxen ownership

Oxen are the most important production assets for farmers in mixed farming mode of production. A pair of oxen is an indispensable input in crop production system. Besides in the study area, ownership of oxen is an important indicator of the wealth and prestige of households. Lack of oxen is one of the major reasons that force households to rent out farmland. It also hampers land preparation and planting as they can get oxen either under rental arrangements. It is only after owners complete their own plough or through labor sharing arrangements that the oxen-less households would have access to it.

Furthermore, high scarcity of grazing land and animal feed in the study area has caused major constraint to the livestock production system. As a result, supply of oxen for crop cultivation is constrained by this scenario. Out of the sampled households, 33.4% have no oxen, while about 59.9% and 66.6% of food insecure and food secure farm households own at least one ox, respectively. This indicates that food secure households own greater number oxen than food insecure households (see Table 8 below). Thus, the results of chi- square test showed that there is systematic association between oxen ownership and household food security status, at 10% probability level. This clearly shows the significant role of draft power (oxen) in the rural livelihood system of the study area.

Table 8 Number of Oxen and Agro-ecological zone

	Status of HH food security				Total		χ2 Statistics
	Food insecure		Food secure				
	N	%	N	%	N	%	
Ownership of Oxen							
Nil	38	40.1	8	18.6	46	33.4	
One	37	38.9	21	48.8	47	42.0	
Two	18	18.9	11	25.6	29	21.0	
Three	2	2.1	3	7.0	5	3.6	7.313*
Agro ecological zone							
Woina-dega	42	44.2	24	55.8	66	47.8	
Dry woina-dega	53	55.8	19	44.2	72	52.2	1.597(NS)

Source: Own survey, 2008
Note: * Significant at 10%, NS: Not Significant

Livestock production in Sekota *woreda* is based on open grazing on communal land, hillside and aftermath grazing. Hay is used as supplementary feed in dry periods. Farmers conserve crop residues in order to supplement mainly cattle during the dry season since they are the most vulnerable livestock species shortage of fodder. Moreover, the management of the grazing land is carried out by the community through village-level committees. Livestock production is deteriorating on the one

hand because of the decline in grazing land and low biomass, and on the other hand because of widespread diseases.

5.1.2.6. Agro-ecological zone

Sekota *woreda* can broadly be classified into two climatic zones: *woina-dega* and *dry woina-dega* respectively founded on the basis of the traditional classification, based on altitudinal differences. The agro-ecology potential has very broad dimensions because it includes a multiple aspects (i.e. rainfall, soil quality, soil erosion and altitude). Therefore, it determines the type and level of crop production in the particular area.

Generally, in Sekota *woreda* farming system can be characterized as subsistence mixed farming. The low land area (*dry woina-dega*) is mainly characterized by the low and erratic distribution of rainfall. Farmers in this zone have livestock-crop based production system. Hence, the importance of crop cultivation decrease with a decline in altitude and farmers in the *dry woina-dega* mainly depend on livestock production. On the other hand, the *woina-dega* climatic zone is characterized by relatively less erratic and adequate amount of rainfall. Thus, the area is suitable for growing all types of crops including fruits and vegetables and farmers in the area have crop-livestock based production system.

Table 8 presents, the distribution of sampled households by their agro-ecological zone. Accordingly, 47.8% and 52.2% of the total sampled households were found in *woina-dega* and *dry woina-dega* agro climatic zones, respectively. Since most crops produced by farm households in the area are meant for consumption, diversification of different crop varieties has an advantage as a strategy to avert risk of crop failure.

As a result, it was hypothesized that farmers in the *woina-dega* zone are more likely to be food secure than those in *dry woina-dega* climatic zone. However, the chi-square analysis showed no systematic association between agro-ecologic zones of farm households and food security status.

5.2 Institutional Characteristics of Sampled Households

5.2.1. Land Security

Land tenure has important implications in agricultural development in general and environmental conservation in particular (Kirk cited in Kumela, 2007).The Amhara National Regional state issued a proclamation to determine the administration and use of rural land in 2000. Without going into the details of the proclamation, the current registration and distribution of land use certificate given to land holders serves as a good starting point to focus on the rural land problem. In the Amhara National Regional State (ANRS), where this study was undertaken, land redistribution has been a very common phenomenon. Particularly, in the study area, respondents exposed that they have witnessed different redistributions programs since the previous regime. They indicated that the last land redistribution was undertaken in 1987 and 1993.

Belief/perception on land security is one of the determining factors for farmers' to take risk and invest in their farmland either by adopting different inputs and technologies and/or their labor on land conservation measures that can directly or indirectly increase productivity of land and eventually improve food security status. To this end, household heads were asked whether they perceive a risk of loss of their plot of land in the future through land redistribution. Thus, majority (81.9%) of the households did not anticipate loss of their farm plots in the future while few (18.1%) felt loss of their farmland in the future through land redistribution(See Table 9). This

is probably due to the recent development in providing farmers use right of land certificate which has contributed positively to their tenure security. However, the chi-square result showed no significant association between land security and household food security status.

5.2.2. Land tenure arrangements

Involvement in informal land exchange arrangements is common in the study area due to the prevalent problem of land shortage as a result of increasing population pressure. In addition, severe land degradation in the *woreda* has transformed a vast area of farmland out of production. In effect, all these factors have resulted in critical shortage of land. As a way out, renting of land and share cropping have recently evolved as a strategy to acquire optimal size of cropland to produce food for household consumption and to cope up with the risk of crop failure. As such, the prominent share cropping arrangements in the study area are outlined below:

`*Megajo*' or `*Ekul*': A farmer with a better economic condition, in most cases those who have oxen, rents-in land from another farmer and cultivate the rented-in land with their own inputs. The net amount produced is then divided equally between the landowner and tenant (sharecropper). The straw remains with the tenant (sharecropper).

A condition where the landowner gives land and half of the seed: This system is different from the previous, in that, the amount produced and the straw is shared equally.

A condition where the land is considered infertile: Here the amount produced is shared with a ratio of 4 into 1 or 5 into 1 in favor of the tenant.

The above discussed share cropping systems are temporary transfer of land which favors farmers with a better economic condition to get a chance to cultivate a relatively large size of land than what they legally own. On the other hand, the poor farmers obtain some income, or else they would be unable to get any return from their land. Without, '*Megajo*' and other customary institutions, which are important adaptation mechanisms used in study area, the food economy of the *woreda* would have been in serious crisis. Nevertheless, these institutions have their own drawbacks. Firstly, the transfer of land rarely extends beyond one or two harvest seasons which put neither of the party to make long-term plans or properly utilize and maintain the land. Secondly, there is lack of flexibility in terms of cropping since the poorer landholder will be more eager to have his/her land planted with directly consumable food crops.

Table 9 Land tenure and Extension service

	Food insecurity		Food Security		Total		χ^2 Statistics
	N	%	N	%	N	%	
Do you fell that you will loss your farm plots in the future?							
No	68	85.0	27	75.0	95	81.9	
Yes	10	15.0	8	25.0	18	18.1	**1.675(NS)**
Visit by the Development Agent							
No	24	24.5	12	27.9	36	25.5	
Yes	71	75.5	31	72.1	102	74.5	**0.183(NS)**
Training in soil and water conservation							
No	69	72.3	32	74.4	101	73.0	
Yes	26	27.7	11	25.6	37	27.0	**0.065(NS)**
Availability of modern SWC measures in farmland							
No	50	52.6	15	34.9	65	47.1	
Yes	45	47.4	28	65.1	73	52.9	**3.742***
Have you taken soil fertility management training?							
No	75	78.7	31	71.4	106	76.5	
Yes	20	21.3	12	28.6	32	23.5	**0.859(NS)**
Have you applied Manure on your cultivated land?							
No	37	38.9	5	11.6	42	30.4	
Yes	58	61.1	38	88.4	96	69.6	**10.435****

Source: Own survey, 2008

Note: * Significant at 10%, ** Significant at 5 %, NS: Not Significant

5.2.3. Access to Extension service

In a country such as Ethiopia, where the majority of the farmers are illiterate, agricultural extension plays a significant role in assisting farmers to identify and analyze their production problems and make them aware about opportunities for improvement. Hence, the effectiveness of the various production inputs partly relay upon the availability of sound agricultural extension services at community levels. To this end, the *Woreda* Agricultural and Rural Development Office (WADO) is providing this service in the area. Two to three development agents are assigned at each farmers training center (FTC) in each kebeles to give reliable and continuous technical support and advice. Extension agents contact farmers on an individual basis, though farmers who have suitable plots in adjacent locations are teamed up for demonstration. As indicated in the Table 9, about 74.5% of the sample households responded that they were visited by development agents, and there is also no significant difference between the two groups with regard to visit by the development agents. But, most complained about the insufficiency of the service.

5.2.4. External interventions on Natural Resource Management

Table 9 provides an over view of proportion of sample farm households who participated in Natural Resource Management practices. Major areas of intervention in rehabilitating the degraded land of Sekota *woreda* are mainly in Soil and water conservation measures (SWC) and fertility management practices. These are discussed in the proceeding sub-sections:

Soil and Water Conservation

Although irreparable damage has occurred in the study area due to the extensive soil erosion on farmlands, only very little has been done in controlling soil erosion. This is because prior to 1991, the area remained to be a major war zone in the *Derg* regime. Then after, the *woreda* agriculture office and NGOs working in the area have given priority to the problem and have initiated a development intervention project to control soil erosion since 1995. The interventions include construction of stone/soil bunds, stone/soil terraces, diversion channels, gully stabilizers and safe waterways through mass mobilization and food for work program. Moreover, since 2004, community level natural resource management activities have been implemented mainly through Safety net program which was funded by USAID.

Out of the total sampled households, 52.9% reported they implemented modern soil and water conservation measures on their farmland. A higher proportion of food secure households (65.1%) used modern SWC than to the food insecure households (47.4%). (See Table 9). Parallel to this, the chi-square test showed significant systematic association at 10% significant level between implementation of modern SWC and food security status. This association can be attributed to labor intensive nature of most SWC measures (i.e. stone terrace), as food secure households have relatively higher size of active labor to perform such activities in their farmland than food insecure households.

Soil fertility management

In the study area, farmers undertake a range of soil fertility management practices to maintain and/or improve soil fertility status. During the focus group discussion, farmers mentioned the following fertility management practices; application of organic matter like animal manure, household trash and crop residues, SWC measures to control erosion and to some extent there are farmers who use chemical fertilizer. Furthermore, farmers also use crop rotation through alternating legumes in their farm field. (E.g. teff–fababean or field pea)

Earlier farmers had low perception in use of manure to improve soil fertility. But currently, there is a higher tendency of using manure in most areas of the study area. Since 1997, with the intervention of Extension Package Program, farmers have been thought the importance of manure in soil fertility management practice. Since then, some farmers who have the access to manure have been applying it on their fields. On the other hand, cow dung is mostly used as a source of energy and for making *Mugogo*[1] cap. Presently, due to the growing scarcity of fuel wood from time to time, selling dung cake in Sekota town has become a common practice among poor farmers in *Woina-dega* parts of the *woreda*, this is undesirable trend, which is mining the nutrient that otherwise could have entered into the soil, there by enhance nutrient recycling.

Although majority of the sample households (76.5%) reported that they did not take training with regard to soil fertility management, 69.6% of the sampled households applied manure in their farmland. As indicated in table 9, application of manure into farm fields differ among food insecure (61.1%) and secure group (88.4%). This

[1] A household utensil that used for '*Injera*' making

finding is also supplemented by the results of the chi-square test which shows a significant systematic association at 5% significance level between the application of manure and food security status. This is mainly due to larger size of livestock owned by food secure group than food insecure households.

Figure 4 Stack of cattle dung on sell at Sekota market

Thus, it appears to be a good opportunity in the area for the promotion of such land management practice to exploit the complementarities of livestock production that showed supportive link to boost crop production and income at household level. In general, farmers' awareness on the positive effects of organic matter in improving soil fertility has been increased. Apart from fertility maintenance, they indicated that organic matter have improved their soil structure and has suppressed infestation of weed such as *lakay* or *lakenchira* (Striga sp) in their farm field.

Farmers in the *woreda* had never used chemical fertilizer until 1997 to improve the fertility status of their soils. Even after the introduction of Extension Package

Program (EPP), farmers have been unwilling to use chemical fertilizer. Even the very few farmers who participated in the EPP questioned the benefit of fertilizer because it burned their crops and substantially reduced the yield, especially during periods of rainfall scarcity and also if the rainfall stops earlier than the expected offset time. The other important reason for not using fertilizer is its high price. Most of the farmers are resource poor. They can not afford the high price of chemical fertilizer, and have not been interested due to the risk of crop failure.

5.2.5. Participation in Productive Safety Net program (PSNP)

Productive Safety Net Program (PSNP) is a program designed to address the basic food needs of food insecure households. The objectives of the program are to provide transfers to the food insecure population in selected chronically food insecure *Woreda* in a way that prevent asset depletion at the household level and creates asset at the community level (PSNP, 2004).

To this effect, Sekota is one of the chronically food insecure *woredas* in the Amhara region and targeted farmers have been participating in the PSNP since 2004/05. Hence, the results of the survey disclosed that the majority of farmers (60.1%) from the total sample household have been participating in the productive safety net program during the last three consecutive years. Moreover, more than 62% and 55% of the sampled food insecure and food secure households have been involved in the productive safety net program, respectively (See Table 10). As can be seen from the result, greater proportions of food insecure household group are involved in the safety net program, as the initial targets of the program were for poor households. However, results of chi-square analysis showed no systematic association between participation in the productive safety net program and food security status of sample households.

On the other hand, considerable number of the food secure households (55.8%) was also involved in safety net program, which can be attributed to result of its positive impact on food security status of the farmers. It was learned from development agents in the respective sampled kebeles that, so far no graduation of participant farmers has taken place in the last three years. However, graduation should have been taken place annually as clearly indicated in the productive safety net program schedule.

On top of this, farmers were inquired to mention the major drawbacks about the program. Thus, most raised the issue of implementation problem from the initial stage of farmers selection to graduation. Most farmers complained about the selection criteria and the process where it lacks transparency. Moreover, some farmers complained about biases by kebeles officials where they gave more priority for their relatives, friends and neighbors.

Furthermore, farmers complained about three things. Firstly, the overlapping of safety net activities with their own farm operation mainly with preparation of farmland in February and March and this problem is further magnified when there is rain in *Belg* season. Secondly, the problem of limited quota coverage for kebeles exclude eligible households and thirdly the limited duration (six months), that it fail to include seasons of severe food shortage in the area (i.e. July-September).

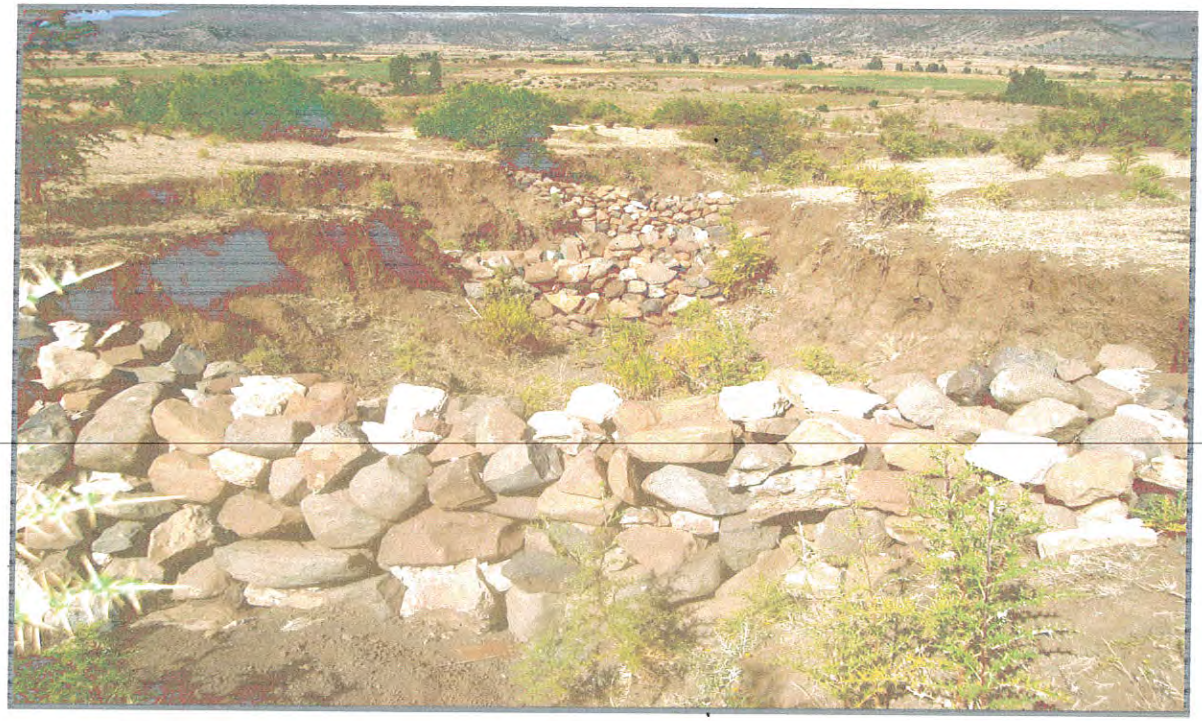


Figure 5 Gully reclamation efforts in communal grazing land

On the other extreme, farmers in the focus group discussion appreciated the program activities because, the interventions are in line with the basic problems of the community (i.e. construction of feeder road, SWC, water harvesting, etc).In doing so, it relieve the food shortage problem of participant farm households.

In nut shell, due to the above mentioned problems, it is almost difficult to determine the effect of involvement in the safety net program towards food security status of household in the study area. Hence, it needs further independent detail investigation on this regard.

Table 10 Summary of Institutional characteristics of sample households

	Food Security Status				Total		$\chi 2$ Statistics
	Food insecure		Food secure				
	N	%	N	%	N	%	
Do you involve in the productive safety net program?							
No	36	37.9	19	44.2	55	39.9	**0.489 (NS)**
Yes	59	62.1	24	55.8	83	60.1	
Have you received formal credit service in the last three year?							
No	37	38.3	18	41.9	55	39.4	**0.157(NS)**
Yes	58	61.7	25	58.1	83	60.6	
Do you have market access problem?							
No	25	26.3	13	30.2	38	27.5	**0.288(NS)**
Yes	70	73.7	30	69.8	100	72.5	
Is there any price difference during food shortage time?							
No	3	3.2	1	2.3	4	2.9	**0.078(NS)**
Yes	92	96.8	42	97.7	134	97.1	

Source: Own survey, 2008
Note: NS: Not Significant

5.2.6. Access to Credit Service

Farmers opt for credit to fulfill their financial requirement. There are institutions, both formal and informal, that are functional in the provision of credit needs in the study area. The major formal sources of credits in the area have been the government and Amhara Saving and Credit Institute (ACSI) and Cooperatives. These institutions focused in rendering credit services to farmers so that they used to purchase assets such as goats and bee hives, oxen and in some cases, to begin petty trade. Thus, it was hypothesized that households who participated in credit service can improve their income status through undertaking different activities with the credits acquired and hence improves their food security.

However, as indicated in Table 10 above, it was found that more than half of the sample household heads (60.6%) reported they received credit at least once in the last three years. In addition, involvement in credit scheme between the two groups illustrate that greater proportion of food insecure households (61.7%) were involved

in the credit scheme at least once in the last three years than the food secure group (58.1%). Moreover, results of chi-square analysis showed no systematic association between participation in the credit service and food security status of sample households.

This can be due the mismanagement of the loan as most households used it to invest it in to their immediate cash need (i.e. to buy food items and for other social obligations). The other reason can be due to, the susceptible nature of farmers' investment to the fragile dry-land nature of the area, as most households use the loan to buy goats and beehives.

Moreover, farmers during the focus discussion mentioned the collateral system, repayment schedule and the risk allowance issues of the credit scheme as the major drawbacks. Informal credit institution, that functions as a source of credit in the study area includes moneylenders, friends, neighbors and relatives. However, as farmers reported, these days receiving loan from these sources is becoming near to impossible due to the prevalence of absolute impoverishment throughout the woreda.

5.2.7. Access to Market centers

Access to food is mediated by market access and price fluctuations. Food price volatility undermines food security for the poor who, by definition, are net food purchasers (Devereux, 2000).Thus, easy access to market center creates opportunity for farmers to additional income source by providing off-farm/non-farm employment, access to farm inputs and fair prices. It was, therefore, expected that households that have easy access to market places have better chance to improve food security status than those who do not have access to market centers.

During informal discussion, most farmers have mentioned a problem of access to market places. As a result farmers are forced to walk long distance for long hours in the inconvenient and rugged topography of the study area to reach the market places. In other words, farmers are forced to travel on average three to four hours of one way walking distance (about 15 kilometers) to reach to the major open market places(i.e. Sekota and Hamusite). Accordingly, as depicted in Table 10 the household survey result revealed, 72.5% of the total sample households, 73.7% of the food insecure and 69.8% of the food secure group reported that they encountered market access problem. Likewise, as the result confirms that both groups suffer the problem of market access. Hence, problem of easy access to market places forbid farmers from merits of better price for their commodity and made them even to incur extra cost. The results of the chi-square analysis showed no significant systematic association between market access problem and food security status.

As shown in Table 10, farmers were asked whether they faced a price change in food shortage season and nearly all the farmers (97.1%) stated that they face increase in price of food crop during food shortage times. Furthermore, informal discussion with farmers disclosed that the prices of the major cereal crops go down in the months between November and March and surge from April to October. The rise of price in the later months is due to huge gap in supplies leading to high demand in the market. Most of the farmers sell their produces immediately after harvest to meet immediate cash demands. Since these farmers do not have adequate grain for seed, family consumption and other social obligations they are forced to purchase in the later seasons for seed and consumption with higher prices resulting in of win-lose game.

Besides, farmers resentfully pointed out the soaring price of food crops during the study period very differently, even though the survey was conducted immediately after the harvest where normally food crops should have lower price.

5.3 Agricultural Production and Causes of Food shortage

5.3.1 Crop Production

The major crops grown in the *woreda* are cereals, pulses and oil crops, with small proportions of fruits and vegetables (WADO, 2006). Among cereals, teff, barley and sorghum are the most important crops in terms of area coverage and amount produced (See Table 11 below). In dry land areas like Sekota, the amount of crop harvested is strongly related to the size of cultivated land.

Table 11 Crop type and coverage

Crop Type	Production(qt)	Area coverage(ha)	Yield (qt/ha)
Teff	150.970	57.600	2.621
Sorghum	214.650	48.750	4.403
Barley	259.620	64.705	4.012
Fababean	238.750	48.900	4.882
Wheat	65.040	16.700	3.894
Chickpea	6.250	11.625	0.537
Field Pea	17.375	10.250	1.695
Noug	3.730	4.625	0.806
Linseed	7.850	6.125	1.281
Beans	26.410	8.950	2.950
Maize	1.750	2.500	0.700
Lentil	6.870	3.975	1.728
Total	999.265	284.705	3.509

Source: Own survey, 2008

Accordingly, the intent to increase crop output by farm households largely relies on expanding farmlands. As such, as Table 11 depicts that, barley leads by area coverage and production. The other major crops with respect to harvest size include fababean, sorghum and teff. These crops constitute about 86.1% of the total crop harvests during

the study year. However, yield in (qt/ha) of major crops, is very low when compared with the national averages. The most productive crop is fababean (4.88 qt/ha) and the lowest are Noug (0.8 qt/ha), maize (0.7 qt/ha) and chickpea (0.5 qt/ha) just less than a quintal.

So far lesser emphasis on research is given to moisture stressed and low resource potential areas (i.e. dry-land) in the country for the last decades. As a result, recommendations are missing for sub-moist drought prone, semi-arid and arid lowlands (HARC, 2000). As learned from the discussion with researchers in Crop Breeding division of Sekota Dry-land Agricultural Research Center (SDARC), the number of improved varieties known to the area are limited. These include Teff Cross 37, DZ-196, *Enkoy* (wheat) and Tritical. However, none of the varieties were released from the research center. They are rather introduced through extension service and relief programme.

Furthermore, as learned from the discussion the local crop varieties in most cases overtake other similar improved varieties that are released from other research centers in most adaptation trials. This is because the local varieties have long years of adaptation to moisture deficit and dry-land nature of the area. Moreover, farmers' knowledge about each variety is limited as the dissemination and adoption of these genotypes are very limited.

A number of factors can be exhibited, ranging from biophysical to socio-economic factors, which can explain the decline in crop yield, even though it demands a detail investigation. However, the focus group discussion revealed that, the major causes of decline in crop production in the area includes shortage of farmland, inadequate rainfall, severity of land degradation and prevalence of crop pest.

The shortage of farmland hindered farmers from exercising traditional soil fertility improvement and maintenance practice such as fallowing. Drought, the effect of rain shortage, is the other major problem of the area. Decrease in yield or even a complete crop failure due to rainfall shortage is a common phenomenon to the area, as rainfall amount and distribution worsen through time. In addition to the formidable constrains indicated above, crop pests are also among the most important production constraints that cause complete crop failure or terminate growth of a particular crop. Due to the ecological imbalance that lasted for many years or other uninvestigated reasons the prevalence of crop pest and diseases are very high. Farmers recognized the problem induced by pests in the field and store. Among many crop pests, farmers consider *Wollo* bush cricket (*fintara*) as the most serious pest attacking sorghum, wheat, barley and teff in the field.

Table 12 Prevalence of crop pest problem

	Food insecure		**Food secure**		**Total**		**χ2 Statistics**
Do you have crop pest problem in your farm plots?							
	N	%	N	%	N	%	
No	25	26.3	20	46:5	45	32.6	
Yes	70	73.7	23	53.5	93	67.4	
Total	95	100.0	43	100.0	138	100.0	5.494**

Source: Own survey, 2008,
Note: ** significant at 5%

The survey result indicated in Table 12 reveal that the majority of sample households (67.4%), reported the presence of from the problem of crop pest in their field. In addition, a slight difference was observed among the two groups in which food insecure households (73.7%) experience the problem of crop pest infestation more than food secure households (53.5%). Hence, chi-square result revealed there is systematic association between the problem of crop pest and food security status of the sampled household heads.

The difference could be attributed to the management measure taken by farm households. As pest management is a well developed practice in the study area particularly those related to cultural practices. Farmers reported that they use an array of pest management practices ranging from single control measure (i.e. hand picking, application of Ash and cow urine, light trap, plowing around the field, etc) to application of pesticide in case of pest outbreaks. Hence, as most of the controlling measures demands labor, it favors the food secure households.

5.3.2. Causes of Food Shortage

In order to identify the major causes of food shortages at household level in the area, the sample farm households were asked to respond by rating major causes and the level of contribution for food shortage by ranking. Regardless of the differences in perceived magnitude of their influence, farmers ranked shortage of farmland (19.4%) as the first and most influential of all factors under consideration, followed by shortage of rainfall (18.2%) and land degradation (17.4%) as second and third prominent causes of food shortage, respectively at farm household level (See Table 13 overleaf).

Table 13 Perceived Causes of food shortage

	Status of Food security				Total		Rank
	Food insecure		Food secure				
	N	%	N	%	N	%	
Shortage of Farmland	71	20.9	28	16.3	99	19.4	1st
Shortage of Rainfall	62	18.3	31	18.0	93	18.2	2nd
Land degradation	63	18.6	26	15.1	89	17.4	3rd
Crop pest and weed infestation	39	11.5	28	16.3	67	13.1	4th
Absence of Livestock feed	37	10.9	17	9.9	54	10.6	5th
Erratic Rainfall	28	8.3	16	9.3	44	8.6	6th
Farmer Health Problem	19	5.6	16	9.3	35	6.8	7th
Large family Member	20	5.9	10	5.8	30	5.9	8th
Total	339*	66.3	172	33.7	511	100.0	

Note * Percentages and totals are based on multiple responses, Source: Own survey, 2008

Crop pest and weed infestation (13.1%) and absence livestock feed (10.6%) are also important biological factors, ranked as fourth and fifth respectively. At last, farmers ranked health problem and large family size as seventh and eighth factors responsible for causing food shortage at household level in the study area. Thus, there exists no major variation in the perceived ranked causes of food shortage in the area between the two groups.

In general, shortage of farmland due to an increasing population pressure and protracted land degradation in the area, coupled with the shortage and erratic rainfall pattern has greatly affected the agricultural production, and made most farm households more vulnerable and food insecure. Even though there are a multiple of interrelated factors that can shape food access and availability at farm households level, for the purpose of this study major emphasis is given to land degradation and its linkage with household food security status in the area.

5.4 Linkages between Household's Food security and Land Degradation

The following discussion provides detail analysis of the linkage between household's food security and land degradation based on the findings from information on household survey and interview with key informants, supplemented by secondary data whenever necessary. The main types of degradation in the locality are soil erosion, soil fertility decline and low vegetation cover.

5.4.1. Forms of Land degradation

Land degradation is sometimes taken as synonymous with soil degradation. Soil degradation commonly manifests itself through soil erosion and soil fertility decline (Alemneh *et al.*, 1997). In strict sense of word, however, land degradation is more than degradation of the soil (Woldeamlak, 2003). Likewise, farmers in the study perceive land degradation in its broader sense. These include soil erosion, soil fertility decline, loss of vegetation cover and transformation of farmland to rocky bare land. As presented in Table 14, soil erosion was the main forms of land degradation followed by low soil fertility, low vegetation (biomass) cover and farmland rockiness with a proportion of 31.3, 23.9, 22.7 and 22.3% respectively.

Table 14 Forms of land degradation as perceived by sample households

	Status of Food security				Total	
	Food insecure		Food secure			
Forms of land degradation	N	%	N	%	N	%
Soil erosion	87	31.6	40	30.5	127	31.3
Low soil fertility	65	23.6	32	24.4	97	23.9
Low vegetations cover	60	21.8	32	24.4	92	22.7
Farmland Rockiness	63	22.9	27	20.6	90	22.2
Total	275	67.7	131	32.3	406	100.0

Note: Percentages and totals are based on multiple responses analysis.
Source: Own Survey, 2008

As discussed in section 5.1.2.6, the type of farming system of the *woreda* is broadly characterized into Crop-livestock based and Livestock-crop based. Hence, the effects of land degradation on household food security have different form. For households crop major system, soil erosion and soil fertility loss; where as, for households livestock major system, the degradation on grazing lands mainly threaten farm households' livelihood. To this effect, the study associates land degradation and food security, with regard to these major forms (i.e. soil erosion, fertility problem and low vegetation cover).

5.4.2. Soil erosion problem

Sekota is one of those parts of Ethiopia known, by the long history of human settlement. Agriculture is the base of the livelihood for centuries. Because of long time agricultural practice and the mountainous nature of its land form, soil erosion is the major cause for the current highly degraded status of the agricultural land in the study area. Based on farmers response soil erosion is one of the major causes of food shortage in the area (See Table 13).

Majority of the sampled farm households (75.4%) mentioned the presence of soil erosion on their cultivated land. Considering the problem of soil erosion with respect to household food security status, there was very slight difference between the food secure and food insecure groups. In other words, 75.8% of food insecure and 74.4% of food secure households point out the prevalence soil erosion on their cultivated land. This indicates that soil erosion is a common problem for almost every farmer in the area. The chi square result showed that no systematic association between the two groups regarding soil erosion.

Table 15 Problem of soil erosion

	Food insecure		Food secure		Total		χ2 Statistics
	N	%	N	%	N	%	
Is there any incident of soil erosion in your cultivated land?							
No	23	24.2	11	25.6	34	24.6	
Yes	72	75.8	32	74.4	104	75.4	
Total	95	100	43	100	138	100	**0.031(NS)**
Trend of soil erosion over years?							
Increasing	56	78.9	20	46.5	76	55.1	
Decreasing	24	25.3	21	48.8	45	32.6	
No Change	15	15.8	2	4.7	17	12.3	
Total	95	100	43	100	138	100	**8.857****

Source: Own Survey, 2008,
Note: NS-not significant, ** significant at5%

During the field survey, farmers were asked to indicate the rate of erosion over years in their farmland. Out of the total sampled households more than half (55.1%) of the interviewees rated erosion has increasing trend; 32.6% rated erosion has decreasing trend and 12.3% responded no change. With regard to the responses given by the two groups, a larger proportion of the food secure households (48.8%) responded that erosion has a decreasing trend in their farmland than the food insecure households (25.3%) (See Table 15 above). This can be due to the positive outcomes of measures taken to tackle the problem by households. As discussed earlier significant proportion of food secure households constructed soil and water conservation structures in their farmland than food insecure households (see Table 10). Furthermore, the chi-square result also confirmed that there exist a significant association between the trends of erosion on farmer's field and food security status.

Soil erosion causes reduction in infiltration and water holding capacity of the soil as well as a loss of plant nutrients which ultimately results in low productivity (Carucci, 2000). Accordingly, farmers in both groups prioritized that the major consequence of

soil erosion (36.4%) as decline in crop production in the area. The second major consequence was shortage of livestock feed (19.0 %) and increased demand of labor (17.0%) as third.

Table 16 Consequence of soil erosion as perceived by sample households

Consequence of soil erosion	Status of Food security				Total	
	Food insecure		Food secure			
	N	%	N	%	N	%
Decline in crop production	62	35.6	30	38.0	92	36.4
Livestock feed shortage	32	18.4	16	20.3	48	19.0
Demand extra labor for farming activity	34	19.6	9	11.4	43	17.0
Increased weed infestation	19	10.9	8	10.0	27	10.6
Loss of fertility	15	8.6	7	8.9	22	8.7
Loss of farmland out of production	12	6.9	9	11.4	21	8.3
Total*	174	100	79	100	253	100

Source: Own Survey, 2008,
Note: *Multiple response analysis

Furthermore, discussion with farmers in focus group explained how land degradation (soil erosion) is linked with food security status of households in line with major consequences of soil erosion. Crop productivity decline, which directly related with the decrease in amount produced from the cultivated land, undermined direct access to food, which in due course force farm households, to a stage a stage where, they are unable to feed their family members with enough food. Others recount the consequence of soil erosion to household food security status, with decreased income level. In other words, the major source of income for a considerable number of farmers is highly dependent on the sell of livestock. Hence, shortage of livestock feed and scarcity of grazing land due to extensive soil degradation in the area forced farmers to sell their stocks with cheaper price and this situation increase their vulnerability and ultimately leads to household's food insecurity.

The need for extra labor to farm activity mainly manifested in timely farmland management is, reflected as a third consequence of soil erosion. This happens mostly when the extent of degradation reaches a critical level, where visible signs of rills and gullies appeared in the field, which demands the extra household's labor for conservation and reclamation activities (i.e. terracing and gully stabilization) on the farmland. Thus, failure to do so definitely results in substantial loss of crop production, which in turn has a negative effect on household's access to food.

Table17 Causes of Soil erosion as perceived by sample households

Causes of soil erosion	Status of Food security				Total	
	Food insecure		Food secure			
	N	%	N	%	N	%
Deforestation	63	22.9	33	24.8	96	23.5
Cultivation of steep slopes	61	22.2	25	18.8	86	21.1
Absence or weak SWC structures	48	17.5	29	21.8	77	18.9
Excessive rainfall	40	14.5	24	18.0	64	15.7
Continuous cultivation	31	11.3	13	9.8	44	10.8
Over grazing	32	11.6	9	6.8	41	10.0
Total	275	67.4	133	32.6	408	100.0

Note: Percentages and totals are based on multiple responses
Source own survey, 2008

There are various interacting forces, which have caused and are still causing soil erosion in the area. Moreover, many argue that human activities, combined with adverse climatic conditions are responsible for erosion and consequent land degradation. In agreement with this, the result of the survey attributes poor land management manifestations as major driving force of soil erosion in the area. As ranked by both groups in the study, deforestation (23.5%), cultivation of steep slopes (21.1%), excessive rainfall (18.9%) and absence or weak soil conservation structures (15.7%) are the 1st, 2nd, 3rd and 4th major causes of soil erosion (See Table 17).

5.4.3. Soil fertility problem

Next to soil erosion, soil fertility decline is the most important form of land degradation reported by both groups. Farmers in the study area usually rate soil fertility status of a given land with its productivity and soil type/color. Black soil is usually considered more fertile and productive. As such farmers were asked to report the type of soil in their respective farm plots. As indicated in Table 18, the average numbers of farm plots with black and gray soil types differ significantly between the two groups. Food secure households had relatively higher number of farm plots with black and gray soil than food insecure households. Hence, food secure households possessed relatively fertile land than food insecure households.

Table 18 Distribution of farm plots by soil type

Soil type /Color	Food insecure		Food secure		Total		t-Statistics
	Mean	SD	Mean	SD	Mean	SD	
Black soil	0.61	0.879	1.02	1.244	0.74	1.020	2.233**
Red soil	1.03	0.939	1.30	1.551	1.12	1.166	1.267(NS)
Gray soil	0.80	0.406	1.19	1.050	0.92	1.134	1.869*

Source: Own survey, 2008,
Note; NS- Not Significant,* significant at 10%, ** significant at 5%

It as also learned from agricultural experts in the *woreda* that black and gray soil are found on flat to gentle slope lands where there is deposition of fertile soil from the surrounding hills and mountains. However, they indicated that the proportion of flat lands with black soil, which are suitable for crop production, is very small in the *woreda*.

In the study area, soil fertility statuses of farmlands have been decreasing over time as explained by the farmers in the focus group discussion. They underscored that population pressure is the main root cause of the decline in soil fertility (i.e. in land

productivity sense) that has caused shortage of farmland and which ultimately forced a continuous cultivation on existing plots of land. Farmers are very much aware about the purpose of fallowing practice as they used to practice it in the past. However, nowadays fallowing practice is totally abandoned in the area due to severe shortage of farmland. During the focus group discussion, elder farmers narrated those past 'good old days', fallowing practice had been a means to reclaim their depleted farmland (nutrient exhausted due to continuous cultivation) to the state of recovery.

5.4.4. Reduction in vegetation cover

Reduction in vegetation cover reduces the capacity of the soil to retain moisture, which is vital for plant growth. Besides, reduction in vegetation cover also leads to an increase in soil erosion and thus to loss in soil fertility (Bamlaku, 2005). Therefore, there is a direct link between reduced vegetation cover and land degradation. Reduction in vegetation cover is mentioned as third major form of land degradation in the area. Elder informants in the focus group discussion have pointed out that in the past; the area was able to generously support the livestock for a long time. The present state of land is that, the former productive and perennial grasses had completely disappeared. As elder informants described during the discussion, some of the well-known useful grass species that are no longer exist in the surrounding include *tuassa, chuba, latsa, alma* and a tree species of *chechema.*

The main cause for the decline in vegetation cover is could be the outcome of the combined effects of repeated drought occurrences, increased population pressures and the apparent severe land degradation over time. The entire landscape of the *woreda* is now degraded as manifested in the prevalence of bare lands and rocky hills observed almost everywhere. Scattered bushes/shrubs and trees are observed on most of the

denuded grazing lands with periodic rejuvenation. There are also trees and annual grasses which sprout following the rain showers that provide limited amount of poor quality fodder. As a result, livestock had to cover long distance from home yard to graze or browse on these scanty vegetation cover. Yet they hardly meet even their maintenance requirement over the most period of a year. Consequently, animals particularly goats are victimized where even subtle diseases are severely threatening them. Besides, livestocks are exposed to intense sunstroke during the late period of the dry season, at times when feed becomes critically in shortfall and where they do not get shade on grazing lands.

As farmers clearly pointed out in the focus group discussion, the direct effects of low vegetation cover are reflected on livestock through loss of body weight, decrease in productivity and eventually increased mortality of the animals. To minimize the effects of feed shortage, farmers tend to focus more on small ruminants as an adaptive strategy to cope with the rugged cleft massifs of the terrain that would otherwise have remained to be a wasteland. Consequently, one can conclude that, the prevailing situation of livestocks are underfed while at the same time overgrazing intensified on marginal areas, which exacerbated further land degradation (i.e. soil erosion and low vegetation cover).

Figure 6 Scanty vegetation cover on the grazing land

5.4.5. Effect of land degradation on Food security: Farmer's Knowledge

Sampled household were asked if land degradation has affected their food security status. Among the total sample household heads, 71% responded that it has affected their food security status while the rest responded otherwise. (See Table 19 overleaf). Farmers' knowledge and perception of their environment provide essential information on understanding their land management practices (Tesfaye, 2003). Knowing the effect of land degradation on food security can motivate farmers to workout different strategies to reduce the impact or seek other alternatives to cope up with the problem. Accordingly, greater proportions of food secure sample households (79.1%) are aware that land degradation affected their food security status. Hence, the chi-square result showed that there exist systematic significant association (at 10% probability level) between farmers' awareness about the effect of land degradation to food security and their food security status.

Table 19 Knowledge on the effect of land degradation to food security

	Status of Food security						
	Food insecure		Food secure		Total		
	N	%	N	%	N	%	χ2 Statistics
Has land degradation affected your food security level?							
No	31	32.6	9	20.9	40	29.0	
Yes	64	67.4	34	79.1	98	71.0	
Total	95	100	43	100	138	100	**1.969***

Source: Own Survey, 2008.
Note: * Significant at 10%

5.4.6. Effect of Household Food Shortage to Land degradation

Conversely, sample household heads were asked to report the influence food shortage at house hold level on land degradation in the area. More than half (56 %) of the total respondents agreed that household food shortage has accelerated land degradation on the area (See Table 20 below). It was also learned from the focus group discussion that, food shortage forced resource poor farm households to expand cultivation into adjacent marginal areas or areas unsuitable for cropping (steep slopes, area closures and grazing lands) with the main purpose of lessening risks and producing more food. This is again a short term strategy, which then contributes to exacerbation of the already distressed land in the area for further degradation.

Table 20 Effect of food shortage on land degradation

	Status of Food security					
	Food insecure		Food secure		Total	
	N	%	N	%	N	%
Has household food shortage facilitated land degradation in the area?						
No	38	41.8	21	48.8	59	44.0
Yes	53	58.2	22	51.2	75	56.0
Total	91	100	43	100	134	100

Source: Own Survey, 2008

Note: NS-Not Significant

On the other hand, lack of enough food in the household makes farmers to perform poorly in their farmland, especially for high energy demanding farm activities such as soil and water conservation measures (i.e. stone terrace construction). This further speed up land degradation in their farm field. Some farmers also highlighted that food shortage in the household oblige farmers to rent out some portion of their farm plots which obviously discourages long-term investment on the land. In the cases of sever food shortage, farm households are forced to temporarily migrate to other areas, which certainly detaches the farmers from taking appropriate land management measures on their land.

The other effect of food shortage in the household to land degradation is related to households pursuit to enhance their income. In this case, poor farmers involved in selling of fire wood and charcoal, which have negative impact on the biomass of the areas and facilitate further degradation.

Moreover, farmers in the focus group discussion asserted that poor farmers in the area are very well aware about the consequences of their action for on the environment and for future sustainability of their livelihoods. But they have no alternative except to rely on the short term solutions for their survival. Thus, the trend usually is a trade-off between land degradation and the subsequent struggle for survival gains.

Figure 7 Pile of fire wood ready for sell in Sekota market

5.5 Households Coping Strategies

Coping Strategies by the household to the prevalent food shortage mainly include ex-ante actions such as diversification of income sources to ex-post actions adopted at time of distress such as decreasing amount and quality of meals. For the purpose of this study, major emphasis is given to ex-post coping strategies that are taken at time of distress. This was meant to expose the way households manage to survive in the period of acute food shortage so as to identify the pattern of behavior exhibited by farmers in response to the existing shock. The types of strategies employed by households vary depending on the severity and duration of the disruptive condition.

The proportion of households that have adopted one or more coping strategies in the study area indicates the prevalence of food insecurity. The sample households were asked if they have adopted a set of coping mechanisms during the 12 months prior to the survey time and nearly all of them have reported that they have adopted at least one mechanism. Accordingly, as depicted in table 21, the most prevalent coping mechanism endured by the households during the incident of moderate food shortage was reducing the amount of food intake per meal (22.8%). This is followed by decreasing the number of meals pre day (19.5%) and decreasing the quality of meals (15.4%), which are generally related to change in the consumption pattern. The other prevalent coping mechanisms mentioned aimed mainly at increasing alternative income sources, which include borrowing food or money, working as daily labor and selling of livestock.

Table 21Coping Mechanisms during Moderate Food shortage season

Measures taken during Moderate Food shortage	Status of Food security				Total	
	Food insecure		Food secure			
	N	%	N	%	N	%
To reduce the amount of food per meal	41	24.6	25	31.6	56	26.8
Decrease the Number of Meal	38	22.8	9	11.4	47	19.1
To involve as a daily laborer	29	17.4	9	11.4	38	15.4
To rent food or money	17	10.2	11	13.9	22	11.4
To eat less quality food	10	6.0	13	16.5	23	9.3
To Sell livestock	15	9.0	3	3.8	18	7.3
To detain children from school	7	4.2	1	1.3	8	3.3
To sell fire wood	4	2.4	4	5.1	8	3.3
To sell house utensils	3	1.8	3	3.8	6	2.4
To sell farm implement	2	1.2	0	.0	2	0.8
To sell seed that reserve for plantation	1	.6	1	1.3	2	0.8
Total	167	67.9	79	32.1	246	100

Note: Percentages and totals are based on multiple responses.

Source: Own survey, 2008

The multiple response analyses of the coping mechanisms of the sample farmers indicated in Table 21 and Table 22 have shown that coping mechanisms have different patterns among the food insecure and food secure groups. As all farmers

were not equally vulnerable to drought or food shortage, they responded in different ways and sequential patterns. Accordingly, results in Table 21 reveled major variations in the pattern of coping mechanisms experienced among the food insecure and food secure groups during moderate food shortage periods regarding changes their consumption pattern and search for alternatives income sources. Critical evaluation of Table 21 above reveals that households effort to cope with food deficit by consuming lower quality food was not much practiced among the food insecure group (6%) as compared to the food secure group (16.6%). This can be because, to those households consumption of lower quality food is a routine and thus no glaring behavioral change in consumption of such food had been noted even in the period of severe food stress

Table 22 Coping Mechanisms during severe Food shortage at household level

	Status of Food security				Total	
	Food insecure		Food secure			
Measure taken during Severe Food Shortage	**N**	**%**	**N**	**%**	**N**	**%**
To Sell livestock	30	16.7	20	25.0	50	19.2
To request for food aid	28	15.6	7	8.8	35	13.5
To eat less quality food	21	11.7	11	13.8	32	12.3
To migrate to other places	25	13.3	7	8.8	32	12.3
To decrease the Number of Meal	16	8.9	14	17.5	30	11.5
To involve as a daily laborer	19	10.6	7	8.8	26	10.0
To sell seed that reserve for plantation	10	5.6	4	5.0	14	5.4
To sell house utensils	7	3.9	1	1.3	8	3.1
To spent entire day without food	5	2.8	2	2.5	7	2.7
To sell fire wood	4	2.2	2	2.5	6	2.3
To sell farm implement	5	2.8	0	0.0	5	1.9
To rent food or money	3	1.7	2	2.5	5	1.9
To detain children from school	3	1.7	1	1.3	4	1.5
To eat forest fruit	1	0.6	0	0.0	1	0.4
Total	180	69.2	80	30.8	260	100.0

Note: Percentages and totals are based on multiple responses

Source: Own survey, 2008

On the other hand, as it indicated in Table 22, the most common coping mechanisms adopted in times of severe food shortage situation were selling of livestock (19.2%), dependence of food aid handouts (13.5%) and migrating to other places (12.3%). It

was further learned in the focus group discussion that the selling of various livestock in response to food shortage follows a sort of sequential order. In most cases, small ruminants such as goats and sheep are sold in any season when immediate cash is needed. This is followed by heifers and bulls. Under emergency conditions when the farmers face dire situations such as shortage of seed and food, shortages, households sale donkeys, cows and oxen, in the same order. This is a common practice among farmers of the study area in coping food shortage.

As can be seen from Table 22 about 13.3 % and 8.8% of responses of food insecure and food secure group, respectively reported that migration to other areas is the coping mechanism they adopt during severe food shortage situation. Temporal migration to other places in search of jobs as a daily laborer is a common phenomenon practiced among farmers of the woreda. The primary destination of most seasonal migrant in-side the *woreda* is mostly Sekota town but sometimes it can reach to Raya-Kobo, Humera and Bahirdar. Furthermore, as noted in the focus group discussion, majority of farmers are not willing to permanently move to other areas and thus, there is much reluctance on the side of farmers to join the resettlement program which is vigorously promoted by the government.

The above findings are in harmony with the response of one focus group who narrated about the coping strategy to food shortage as follows:

> *"When we encounter such disasters (May God forbids) we respond by reducing the amount of meal we take in a normal times. When the situation worsens we may turn to "Kollo" (roasted grain). If that also becomes dire, we may sell out our livestock at any available price. In far more desperate moments, we may migrate to the near by towns either to work as a daily laborer for those who are stronger or even to beg for the elderly. In spite of all these, we dare not sell our seed stacks. Beyond this we have no other option than to skip even a meal at all. In such situation, the government usually comes up with relief food hand outs which may prolong our survival"*

To sum up, in the period of severe food shortage, the farm households practice the above coping mechanisms. Almost all households encountered food shortage during the months of May, June, July, August and September. However, most households face severe food shortage during August and September. It was learned from focus group discussions, the farm households in the *dry woina dega* ecological zone face severe food shortage more frequently than those in the *woina dega* ecological zone. Months like November, December and January, the majority of the respondent households do not face of food shortage in relative terms.

6. ECONOMETRIC RESULTS

This Chapter is devoted to the presentation of results of econometric analysis (i.e. binary logistic model) on the determinants of inter-household variations in food security status in the study area. The chapter is sub-divided into three parts. Firstly, brief summary of the results of bivariate analysis for the major demographic, socio-economic and bio-physical variables that are discussed in the Chapter 5 is presented. Secondly, model specification and estimation procedure with hypothesized variables sign expectation and their definitions are explained. The last section provides discussion on significant determinant variables of household food security status.

6.1 Summary of Major Variables

In the previous section, bivariate statistical methods, t- test and chi-square test were used to investigate potential directions and associations of the sets of continuous and discrete variables, which were measured respectively in differentiating food-secure and food-insecure households. In this regard, food secure and food insecure farm households differ with respect to some demographic, socio-economic and bio-physical characteristics. Summary of the means of the continuous variables and scores of discrete variables are given in Table 4, Table 5, Table 6, Table 7 and Table 8. Chi-square and t-tests were used to investigate presence or absence of difference between the food secure and insecure groups of farm households regarding the values of each variable.

Accordingly, age of households head, dependency ratio, size of cultivated land, labor, size of rent in land, number of plots, farmland quality index, livestock ownership(excluding oxen), number of oxen, were found to have significant

difference between food secure and food insecure households. On the other hand, off-farm involvement, modern SWC measure, manure application, crop pest prevalence and knowledge about the effect of land degradation on food security were found to have a significant association with household food security status. From the results of the bivariate analysis one can easily ponder two points: Firstly, that food secure households in the area are more resource endowed (Size of cultivable land, number of plots, land quality and large livestock possession).Secondly, food secure households are those who are aware of the problem of land degradation and are able to take responsive measures to the degradation (i.e. SWC or Manure application) and prevalent pest problem in their farmland. However, such tests may hide the confounding effects of other variables that need to be disentangled, and thus econometric analysis for the determinant variables is vital for this purpose.

6.2 Estimation Procedure

6.2.1 Model specification and Variable Definition

Dependent Variable

Household food security: Food security status at the household level was measured using household kilo caloric acquisition method. Conversion of gross household food consumption into calories, and dividing the calories figure by the number of adult equivalents in the household and the number of days in the recall period (14 days). This gives results in a figure for average calories consumed per adult equivalent per day, which is then compared with an estimate of caloric requirement. Thus, those households beyond the estimate caloric requirement level ($\geq$ 2100 cal per person per day) were deemed to be food secure and otherwise food insecure. (See Table 3).

The study utilized a probability model specified with food security as a function of series of explanatory socioeconomic, demographic, institutional and biophysical characteristics of households, as indicated below in the last section, The dependent variable is a dummy variable, which takes a value of zero or one depending on whether or not a household is food secure (i.e. Food secure=1 and Food insecure=0).

Logit model is used to estimate dependent dichotomous variables. Although linear probability model is the simplest method, it is not logically attractive model, because it assumes the conditional probability increases linearly with the value of explanatory variables. Unlike linear probability model, logit model guarantees that the estimated probabilities increase but never step outside the 0 – 1 interval and the relationship between probability (Pi) and explanatory variable (X_i) is nonlinear (Gujarati, 1998).

Thus, a logistic model is used to identify the determinants of food security and to assess their relative importance in determining the probability of being in food secure situation.

The functional form of Logit model is specified as follows, Gujarati (1998)

$$P_i = E(Y = 1/X_i) = \frac{1}{1 + e^{-(\beta_o + \beta_i X_i)}} \quad \text{---------- (1)}$$

For ease of exposition, we write (1) as:-

$$P_i = \frac{1}{1 + e^{-Z_i}} \quad \text{---------- (2)}$$

The probability that a given household is food secure is expressed by (2) while, the probability for food insecure is:-

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad \text{---------- (3)}$$

Therefore we can write:-

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} \quad \text{----------} \quad (4)$$

Finally, taking the natural log of equation (4) we obtain:-

$$L_i = \ln\left[\frac{P_i}{1-P}\right] = Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad \text{------(5)}$$

Where Pi = is a probability of being food secure ranges from 0 to 1

Zi = is a function of n explanatory variables (x) which is also expressed as:-

$$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \quad \text{----------} \quad (6)$$

β_0 is an intercept

β_1, β_2 ------ β_n are slopes of the equation in the model

Li = is log of the odds ratio, which is not only linear in X_i but also linear in the parameters.

Xi = is vector of relevant household characteristics

If the disturbance term (U_i) is introduced, the Logit model becomes

$$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + U_i \quad \text{----------} \quad (7)$$

Independent Variables (X's): Various socioeconomic and biophysical household characteristics expected to affect household food security in the study area.

Thus, based on information from the related literature, previous food security studies and the researcher's personal knowledge regarding the area and conditions of farmers, nineteen potential explanatory variables, which are expected to have significant impacts in determining the food security status of household in the study area were

selected and hypothesized. However, variable such as land tenure security and involvement in safety net program are not included in the model. The former due to lack of variability among the sample households and the later due to introduced bias in participant selection process as discussed in the preceding section. Thus, the major explanatory variables that are hypothesized to have positive or negative influence on household food secure security status are described below. Hence, the study forwarded the following working hypothesis at the outset.

1. Male, older and literate household heads who are relatively resource endowed with larger (size of cultivable land, labor, numbers of plots, land quality index and livestock number (excluding oxen), number of oxen are expected to be food secure.
2. Households who are aware of the problem of land degradation on food security and undertake responsive measures to land degradation (i.e. modern SWC and Manure application) are expected to be food secure.
3. Farm households with access to institutional services (i.e. extension service, credit service and market center) are expected to be food secure.
4. Households residing in *woina-dega* agro ecological-zone have better probability of being foods secure than those in *Dry woina-dega* agro-ecological zone.
5. Households who are no crop pest problem in their field and low dependency ratio are expected to be food secure.
6. Households who have access to off-farm are expected to be food secure.

The following table summarizes the explanatory variables that are used into the model. Hence, the list of these variables as well as their codes and definitions are given below.

Table 23 Definition of variables and sign of expectation

Variable name	Definition of variable and values with their expected sign
X1 =AGEHH	Age of the household head in years, expected sign of coefficient is **positive**
X2=EDUHH	Literacy status of the household head; 1if literate and 0 otherwise, expected sign of coefficient is **positive**
X3=DEPRAT	The ratio of the total family members with age less 14 and above 64 to active member of the household (age group 15-65), expected sign of coefficient is **negative**
X4=LABOUR	The economic active labor force in the household, expected sign of coefficient is **positive.**
X5=OFFHH	whether a farmer engaged in off-farm employment; 1 if a farmer has off-farm employment and 0 otherwise, expected sign of coefficient is **positive**
X6=TOLCULAN	The total size of cultivated farmland, in hectares, expected sign of coefficient is **positive.**
X7=EXTLU	Total Livestock holding in Tropical livestock unit (TLU), expected sign of coefficient is **positive.**
X8=LAQULTIDEX	Total score of land quality index, expected sign of coefficient is **positive.**
X9=PESTPRO	whether a farmer perceives the occurrence of crop pest problem in his/her plots; 1 if he/she perceives 0 otherwise, expected sign of coefficient is **negative.**
X10=AGROCEO	Agro-ecological climatic classification of the farm household; 1 if farm households are in *woina dega* agro ecological zone and 0 otherwise, expected sign of coefficient is **positive.**
X11=KNOWLINK	whether a farmer aware of the effect of land degradation on food security; 1 if the household head aware of the effect of land degradation on food security and 0 otherwise, expected sign of coefficient is **positive.**
X12=MARKT	whether the household has a problem of access to market centers; 1 if household head has a problem of access to market and 0 otherwise, expected sign of coefficient is **negative.**
X13=CREACC	whether a farmer obtained credit: 1 if household head obtains and 0 otherwise, expected sign of coefficient is **positive.**
X14=SWC	Whether SWC technology (stone terrace/ bund) is present on at least one plot; 1 if stone bund is found on at least one plot and 0 otherwise, expected sign of coefficient is **positive.**
X15=MANURE	whether households apply organic fertilizer (Manure) to farm fields; 1 if households apply manure and 0 otherwise, expected sign of coefficient is **positive.**
X16=EXTENSION	whether a farmer has access to agricultural extension service through development agent visit; 1 if a household head has access to extension service 0 otherwise, expected sign of coefficient is **positive.**
X17=SEXHH	whether a sex of the household head is male: 1 if male and 0 otherwise, expected sign of coefficient is **positive.**
X18= NUMOX	Total number of oxen holding in Tropical livestock unit (TLU), expected sign of coefficient is **positive.**
X19= FARMFRAGMENT	Total number of farm plots, expected sign of coefficient is **positive.**

6.3 Determinants of Household's Food security

A number of factors were postulated to influence the food security status of households. With highly significant model chi-square statistics (X^2) 85.33 values (with 19 degree of freedom) and a 120.72 log likelihood ratio, the model achieved 85.9% correct prediction. Figures for correctly predicted food insecure and food secure households were 92.6% and 70.8% respectively. Among the factors considered in the model, seven variables are found to have a significant and positive influence on food security status of households and one factor dependency ratio is found to have a significant and negative influence on food security status of households (Table 22).

The variables included in the model were tested for the existence of multicollinearity using contingency coefficient and variance inflation factor (VIF) for dummy and continuous variables respectively. The contingency coefficient for the dummy variabies included in the model was less than 0.75 which suggests no multicollinearity problem as depicted on Annex IV. Similarly the results of the variance inflation factor confirmed the non-existence of association between the continuous variables (See Annex V).

Total nineteen variables were hypothesized and tested to determine household food security status and out of these analyzed variables, age of household heads, livestock ownership (excluding oxen) in TLU, number of oxen, dependency ratio, total cultivated land, land quality index, application of manure and farmer's knowledge about the effect of land degradation to household food security status were found to be significant determining factors of food security status of households in the study area.

Table 24 The maximum likelihood estimates of the binary Logit model

	B	Sig.	Exp(β)
AGEHH	0.067**	0.027	1.069
SEXHH	0.858	0.200	2.359
EDUCHH	0.191	0.732	1.210
OFFHH	-0.347	0.578	0.707
DEPRAT	-1.096***	0.003	0.334
LABOR	0.134	0.842	1.144
TOLCULAN	0.576*	0.061	1.779
EXTLU	0.288**	0.019	1.334
NUMOX	0.913**	0.013	2.491
LAQULTIDEX	0.122*	0.073	1.130
PESTPRO	-1.693	0.354	0.184
AGROECO	0.604	0.114	1.830
FARMFRAGMENT	0.079	0.648	1.083
EXTENSION	0.130	0.834	1.138
SWC	0.088	0.887	1.092
MANURE	1.602**	0.021	4.964
CREACC	-0.195	0.747	0.823
MARKT	-0.296	0.637	0.744
KNOWLINK	1.129*	0.069	3.092
CONSTANT	-7.794	0.000	0.000
-2Log likelihood	120.72		
Model chi-square	85.355***		
Correctly predicted food insecure	92.6		
Correctly predicted food secure	70.8		
Over all cases correctly predicted	85.9		

Note:*significant at 10%, **significant at 5%, ***significant at 1%
Source: Model output

Age of Household Head (AGEHH): Age of the household head was found significant at 10% significance level and it is positively related with food security status of the households in the study area. This implies that, other things remaining constant, as the age of the household heads increase the likelihood to be food secure increase by a factor of 1.069. This is due to as age of household head increases, the experience of farming increase and the capacity to avert risk increase through either accumulating assets or intensifying and diversifying agricultural practices. The result is in agreement with the findings of Abebaw (2003).

Dependency ratio (DEPRAT) : Dependency ratio was found significant at 1% significance level and negatively related with food security status of the households in the study area. This presume that, other things remaining constant, as dependency ratio of households increases by one unit, the likely probability to become food secure decreases by a factor of 0.334. An increase in the dependent family members increases the demand for food in the household, which results more mouth to feed as compared to limited supply of food in the household.

Livestock ownership (excluding Oxen) in (EXTLU): Ownership of livestock (in TLU) was found significant and positively related (at 5% level) with the household food security status. When livestock owned increase by one unit, the probability of a household to become food secure, ceteris paribus, increases by a factor of 1.334. The possible explanation is that owning large size of livestock (cow, heifer, calf, donkey, goat, sheep and chicken) puts a household in better position to be food secure than households with lesser or no livestock. This is due to the fact that, first livestock production is a major source of income and this enables farmers to purchase food

items during period of food shortage. Second, livestock serve as source of food (milk and milk products, meat, egg) with higher nutritional value.

Cultivated farm size (TOLCULAN): In this study it is expected that the larger the size of cultivated land the greater the probability of food security status. Cultivated farm size of was found to have a positive and significant (at 5% level) influence on household food security status. This implies, all other variables remaining constant, increase in a unit of cultivated farm size would result in an increase in the probability of being food secure by the factor of 1.779. Hence, additional land added through rent in or other tenure arrangements increased the size of cultivated farmland to the specific households. In dry land areas like Sekota increase in the size of cultivated land plays a significant role for households' access to food. Accordingly, this result is consistent with those found by Mulugeta (2002); Abebaw (2003) and Ayalew (2003).

Number of Oxen Owned: Oxen are among the most important factors of production and hence determine household food security status. As it has used as a major draft power in the preparation of land and has significant contribution in the supply of food grain for a household. In agreement with prior expectation, number of oxen owned by the household affects household's food security positively at a probability level of 5%. The more the number of oxen available to households the larger is the probability of being food secure. The positive sign of this variable indicates the contribution of oxen ownership towards ensuring food security.

Knowledge about the effect of land degradation on food security (KNOWLINK): It is found that farmers' knowledge about the effect of land degradation on household food security status determine positively and significantly (at 10% level) the food security status of households. Hence, the odds ratio in favor of food security

increases; other things remain constant, by a factor of 3.092 as farmers became knowledgeable about of the effect of land degradation on food security. This can be due to that farm households who are aware of the effect of land degradation to food security may devised different livelihood strategies that either enhanced their production (i.e. farmland extensification through renting in or share cropping) or halt the problem of land degradation (i.e. farmland intensification through adoption of SWC measures or application of manure). The study result is also in accordance with findings of Genene (2006) that increased farmer's perceptions level of land degradation affected their food security status positively and significantly.

Land Quality index: this variable found out to have positive and significant (at 10%) influence on household food security status. The possible explanation is that, the likelihood to become food secure among households increase with the higher land quality index score. This can be due to farmer's access to better land quality and the positive effects of land management measures (i.e. SWC and Manure application) against soil erosion. This entails that, other things remaining constant, as the land quality index score increases by one, the likely probability to become food secure improve by a factor of 1.130.

Application of manure: have come out to be significant (at 5%) and positive influence on the food security status of the household. The possible explanation is that those farmers who applied manure to their farmland is more likely to be food secure than those who did not. This can be due to the positive effect of application of manure to enhance land fertility which in turn improve crop production in a given farmland. Moreover, access to this resource may be related with increased possession of livestock by food secure households. Thus, if other factors are kept constant, the odds

ratio in favor of being food secure increases by a factor of 4.964 as a farmer gets access to the use of manure.

The logistic regression model result show that, though not significant, sex and educational status of the household heads has a positive coefficient which implies that male headed and literate households have a higher probability of being food secure than female headed and illiterate households. In the same manner, household access to extension service and implementation of modern SWC are not significant in the model result but their positive coefficient indicates their positive contribution to household food security status in the area.

Contrary to the prior expectation, access to credit service and off-farm involvement of households are found to have negative and not significant coefficient depicting those households who did not take credit from formal sources and farmers who did not involve in off-farm activities have higher probability of being food secure. The reason might be attributed to that, the former; farmers who take credit most of the time fail to invest for the right purpose, where their immediate needs (i.e. food) overweigh. The other possible reason might be the recurrent drought and dry-land nature of the area makes it difficult for the susceptible enterprises like goat and bee, thus farmers forced to repay back by selling their oxen or other productive assets. The later, might be attributed to the absence well developed off-farm opportunities that are available in the area and thus landless and poor farmers usually prefer to involve in such activities.

7. CONCLUSION AND IMPLICATIONS

7.1 Conclusion

Given the significance of ensuring food security at household level in Ethiopia, micro-level analysis on the linkage between food security and land degradation, must be given due emphasis and adequate considerations. As such, this chapter presents what has been learned from the study as conclusion and forwards possible implications for various stakeholders and development agents to address these problems.

This study was conducted in north eastern Ethiopia, where food insecurity is almost all season concern of the rural households. Presently, food insecurity is now a rampant problem in Wag-himra zone of Sekota *woreda*. The fragile natural resource base (i.e. land resource) that governs and supports the entire fabric of the rural livelihood is threatened by almost all forms of degradation (i.e. soil erosion, soil fertility decline and low vegetation cover). To this effect, the level of resource loss and depletion increased and it is expanding at a faster pace beyond the capacity of the land users to control.

The prolonged effects of poor land management and ever-increasing population pressure coupled with rugged terrain in the area has resulted in land resource degradation, which in turn responsible for low productivity and diminishing cultivable land holding per household. As agriculture is the heart of the rural livelihood system in the area and land is the primary and most direct recipient of the effects described

above. Shortage and decline in farmland productivity are the major responsible factors for household food shortage, and thus most of the farming households have difficulties to cope with the challenge even during normal rainy seasons.

There is a synergetic linkage between food shortage and land degradation: poor land quality leads to lower yields, and hence food shortage at household level. This necessitates greater exploitation of marginal land and/or shorter time to invest in land management practices (i.e. SWC and manure application) as income must be earned through off-farm activities, this further aggravates degradation. Therefore, this vicious circle call for immediate interventions by all stakeholders before it reaches to a state of ultimate social and environmental collapse.

The result of logistic regression analysis disclosed that the determinants of household's food security are characterized by distinctive socio-economic and biophysical features that are mostly attributed to resource rich and/or endowed farmers. In other words, these households they maintain greater herd size and cultivate on relatively larger farmland size as compared to the food insecure ones. Besides this, many of them own relatively better land quality (i.e. less affected by soil erosion). Apparently, food security (availability and access to food) by households is assured either by increasing their livestock or through expansion of their crop production (extensification) strategies in their livelihood system. However, the long term sustainability of such strategies is very much threatened by the ever shrinking grazing land and declining trend in size of cultivable land. Without sustainable land management strategy the long-term sustainability of food security is under question.

In nut shell, food shortage, protracted land degradation and decline in agricultural production at household level are proved to be intricate and interlinked problems exerting greater challenge on the rural livelihood of farm households in the study area. **Will there be a possibility, at least, to halt these ever worsening problems?**

Though it may be difficult, it should not be impossible as far as there is a genuine willingness and commitment from side of the government and other stakeholders. Hence, based on the assessments of the existing scenario on the problems of food security and land degradation in the area, appropriate strategies and a range of intervention options, that are viable both in light of short and long-term food security perspectives, are suggested in the following section.

7.2 Implications

Even though farmers are exposed to the same bio-physical environment, their understanding of the process and subsequent action to land degradation may vary. In this study, it was found that those farmers who are aware of the effect of land degradation on food security are more likely to be food secure. Therefore, similar and consistent effort should be made to improve farmers' awareness on land degradation problems. Put it other way, integrating awareness creation on the principles of sustainable land management into the extension services could help to improve farmers' capacity to innovate and adapt technologies to their particular situation and protect land resource from degradation. Furthermore, promotion adult education programs would also serve this purpose.

Livestock are very important in the livelihood strategies of most rural farm households of north-eastern Ethiopia in general and in the study area in particular.

Mere reliance on crop production seems necessary but not sufficient to sustain the livelihood of the farming households without livestock production. As an integral part of farming system, livestock production contribute meat, milk, manure, and traction as well as crucial asset to be converted into cash in the time of distress.

The findings this study revealed in crystal clear that, livestock possession (both oxen and other livestock) contribute positively to the food security status of the household. However, keeping livestock in drought prone areas like Sekota pose some degree of risk, as they are prone to substantial losses during drought seasons due to feed shortage and price fall. Thus, efforts to develop rural financial institutions, providing farmers remunerative and less risky saving alternatives to holding livestock as a store of wealth could be helpful (Pender *et al*, 2004).

Provision of water, feed and fodder availability and quality are needed to tap the potential contribution of livestock production in the area. Without integrating adaptive fodder trees, shrubs and/or fast growing grass varieties into the communal grazing lands and area closures to increase the biomass productivity of such areas, the productivity of livestock will continue to be limited by the inadequate productivity of the natural vegetation.

The total population of Sekota woreda with a density of 53.7 person per square kilometer. This figure may not look very much alarming compared to the highly populated areas of the Southern and Central parts of Ethiopia like *Sidama*, *Wolayta, Kenbata* and Eastern *Harergie*. However, considering the amount and fertility status of the cultivated area available and its proneness to drought and other natural calamities, the land is over burdened. Thus, the current status of population growth in

such area is a phenomenon that needs an immediate action. As discussed in the foregoing part of this paper, households with large (dependent or inactive) number of family member are most likely face food insecurity problem because of high dependency burden. Thus, the government and NGOs, particularly operating at the grass root level should design and implement sound programs to enforce the already endorsed population policy in to effect. To this end, the focus must be on family planning and integrated health service and education provisions must catch the attention of decision-making bodies.

In bad season, moisture stress is not only causing total crop failure but also aggravates the livestock feed problem as well as decreases river and ground water recharge. To tackle this problem, the *woreda* has some opportunities that need consideration. There are a good number of rivers and springs, which are flowing all year round these, could be harnessed and utilized through small scale irrigation. Hence, an introduction of small scale irrigation can enhance food security of the households as it ease frequent crop failure due to drought and erratic rainfall. However, such efforts must be carefully designed and implemented (especially if done on large scale).

It was discovered that factors related to institutional services (i.e. extension and credit) were found to have negligible contribution to household food security. Thus, the primary step to provide these services is, identifying and promoting profitable income generating strategies and sustainable land management practices in different bio-physical and socio-economic contexts of the rural poor farm households. To this end, agricultural research and extension are vital to enhance the productivity of the agricultural production systems with judicious use of natural resources for attaining

food security and sustainable agricultural development through synchronized, farmer-centered and demand- led approach.

Lastly, the livelihood of many households in the *woreda* was and is seriously affected by recurrent drought and food shortage. Thus, although food assistance may not be long-term solution to the underlining causes of household food insecurity, it seems imperative to continue the relief handout for some time for those who have no access either to produce or buy food. But, the link with the employment generating system would help both in reducing dependency syndrome and contributing to local development as well as resource management.

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APPENDICES

Appendix 1 **Conversion factors used in estimation of man-equivalent (ME).**

Age Group	Male	Female
< 10	0	0
10-14	0.35	0.35
15-50	1	0.80
> 50	0.55	0.50

Source: Storck, et al. (1991)

Appendix 2 Conversion factors used in estimation of tropical livestock unit (TLU)

Livestock	Average Biomass (Kg)	TLU Equivalent
Camels	250	1
Cattle	175	0.7
Sheep/Goat	25	0.1
Horses/Mules	200	0.8
Donkeys	125	0.5

Source: Storck, et al. (1991)

Appendix 3 Total and effective Rainfall of Sekota *Woreda*

Month	ETo (mm/d)	Total Rainfall* (mm/month)	Effective Rain* (mm/month)
January	0.00	4.7	4.7
February	0.00	13.2	12.9
March	0.00	49.4	45.5
April	0.00	68.5	61.0
May	0.00	60.8	54.9
June	0.00	39.3	36.8
July	0.00	174.0	125.6
August	0.00	215.0	141.0
September	0.00	62.0	55.8
October	0.00	15.0	14.6
November	0.00	12.5	12.3
December	0.00	6.6	6.5
Total (mm/Year)	0.00	721.0	571.6

Note: * Weighted average of 30 years data

Appendix 4 Variance Inflation Factors (VIF) of Continuous variables

Variables	R_j^2	$VIF(x_j)$
AGEHH	0.175	1.21
DEPRAT	0.298	1.42
LABOUR	0.005	1.00
TOTALCULAN	0.212	1.27
LAQULTIDEX	0.270	1.37
NUMOX	0.030	1.03
FRAMFRAGMENT	0.410	1.69
EXTLU	0.193	1.24

Source: Own computation, 2008

Appendix 5 Contingency Coefficients for Discrete Explanatory Variables

	EDUHH	OFFHH	PESTPRO	AGROCEO	KNOWLINK	MARKET	CREACC	SWC	MANURE	EXTENSION	SEXHH
EDUHH	1	0.231	0.112	0.122	0.331	0.266	0.005	0.230	0.162	0.722	0.456
OFFHH		1	0.331	0.266	0.005	0.230	0.162	0.722	0.034	0.039	0.689
PESTPRO			1	0.345	0.111	0.530	0.562	0.822	0.531	0.266	0.691
AGROCEO				1	0.3421	0.030	0.162	0.022	0.037	0.035	0.109
KNOWLINK					1	0.1130	0.231	0.112	0.1242	0.355	0.113
MARKET						1	0.530	0.562	0.822	0.531	0.266
CREACC							1	0.030	0.162	0.022	0.005
SWC								1	0.231	0.199	0.422
MANURE									1	0.093	0.612
EXTENSION										1	0.531
SEXHH											1

Source: Model output

Appendix 6 Questionnaire for the Formal Survey

Questionnaire Prepared for Linking Food security and Land degradation: In drought prone areas of northeastern Ethiopia highlands: The case of sekota *woreda*

Date (Eth Calendar)_____
Name of *Gott* _____
Enumerator Name_____
Starting time _____
Ending time_____

Part I. General Information

1. Sex of the household 1. Male 2. Female
2. Age of the household head: _____
3. Social status or responsibility 1. Religious leader 2. Political leader 3. None 4. Other specify_____
4. Total family size the household? _____
5. Educational level of the household 1.Illiterate 2) Read and writes 3.Primary school 4. Secondary school 5. Other specify_____
6. Marital status of the household 1. Unmarried 2.Married 3. Divorced 4. Widowed
7. Farm experience (Number of years since started farming) of the household head _____ years.
8. Please list the age category of your family members

Age Category (Years)	Sex		Total
	Male	Female	
Children less than and equals to 10			
Children 11-14			
Adults 15-64			
Elders over 64			

9. Do you or any of your family members engaged in any off- farm activity? 1. Yes 2. No
10. If your answer is yes to Qn. 9 .Please mention the type of activity and the amount of money earn?

Type of activity (Code A)	Family member	Amount of money earned annually*

Code A 1. Weaving/spinning 2. Milling 3. Other handcrafts (pottery, metal works, etc) 4. Livestock trade 5. Sale of local drinks 6. Agricultural employment 7. Pity trade (grain, vegetables, fruits, etc.) 8. Sell of firewood and grass 9. Daily labor 10. Others (specify)

*** If payments were made in kind, convert them to Birr at the prevailing price**

11. If your answer is Yes to Qn 9, Does the off- farm job affect your farming activity? 1. Yes 2. No
12. Have you received any other income (such as remittances, gifts, aid or other transfers) in 2007/8.? 1. Yes 2. No If yes what amount (in birr)? _____
13. Do you face labor shortage in farming activity? 1. Yes 2. No
14. Do you use labor outside the family member for farming activity?1. Yes 2. No
15. Do you use hired labor when you face labor shortage in farming activity? 1.Yes 2. No
16. Do you use traditional mutual labor exchange *(Lifint/Debayt)* when you face labor shortage in farming activity? 1.Yes 2.No

Part II. Land Resources

17. Do you have your own farmland? 1. Yes 2. No
18. What is the total size of your land? _____in hectare or local units?
19. What is the total area of land you cultivated in 2007/08? _____in" hectare or local units"
    1. Owned _____ 3. Rented in _____
    2. Share cropped ____ 4.fallow _____5. Others (specify)_____
20. How many number of farm plots you cultivated in 2007/08? _____
21. How is the trend in total area you cultivate from year to year?
    1. Increasing 2.Decreasing 3.No change 4.I don't know
22. How is the trend in total production per unit area from year to year?
    1. Increasing 2.Decreasing 3.no change 4.I don't know
23. If your answer to (Qn.22) decreasing state the reason?

    _____
24. What measure do you take when the productivity of the farmland decline?
    1. Change to other land 2.Try to improve the fertility 3.both 4.other_____
25. If you change to other land, what kind of land you opt for?
    1. Clear forest 2.fallow land 3. Farming grazing land 4. other_____
26. Is your farmland fragmented? 1. Yes 2. No
27. What is the farthest distance of your farm plot from your home? _____
28. What is the nearest distance of your farm plot from your home? _____
29. How many of your cultivated farmland have flat slope? _____
30. How many of your cultivated farmland have gentle slope? _____
31. How many of your cultivated farmland have steep slope? _____
32. Is your piece of land is enough to support your family throughout the year?
    1. Yes 2.No

Part III. Crop production

33. List the type of crops you cultivated and their average production for the year 2007/08.

Crops type	Local /Improved seed	Rain fed/irrigation	2007/8	
			Area (hectare) or in local unit	Total Production (Qt)

34. What kind of crop production trend have you observed for the last five years?
    1. Increasing 2. Decreasing 3.No change 4.I don't know
35. Do you produce enough for your family last year? _____1. Yes 2. No
36. If no, for how long does it last? _____ Months. (Form _____ to_____)
37. Have you encountered any crop pest problem in your farmland/ 1.Yes 2.No
38. What are the major constraints in crop production in your area? (Rank)

Major constraints in crop production	Rank
Erratic rainfall	
Labor shortage	
Less access to input	
Drought (Water scarcity)	
Land shortage	
Soil erosion	
Pest and Diseases	
Other (specify)	

Part IV. Livestock production

39. Do you own livestock? 1) Yes 2) No
40. If your answer is Yes, List down the type and number of livestock you have.

Livestock type	Total population (use numbers)
Ox	
Cow	
Heifer	
Young bulls	
Calf	
Goat	
Sheep	
Donkey	
Mule	
Poultry	
Bee hive	

41. What is/are the main feed source(s) for your livestock?
    1. Grazing 2. Hay 3.Crop residue 4.All 5.others (specify)_____
42. How is the trend in size of grazing land year to year?
    1. Increased 2. Decreased 3.Remain the same 4. I don't know
43. If the answer is decreasing for (Q.41), state the major reason. (Rank)_____
    1. Expansion of farmland 2. Expansion of Area closure
    3. Expansion of settlement 4. Others (specify)_____
44. Have you face any grazing pasture shortage for your livestock last year?
    1. Yes 2.No
45. What was your coping strategy to alleviate this problem in last year?
    1. Move your livestock to other area 2. Sell of them 3.sell some of them
    4. Give collected feed 5. Lopping of trees (cutting of branches) 6.other (specify)
46. Did you collect animal feed to your livestock in last year? 1. Yes 2.No
47. If yes, what were the main sources for this collected feed?
    1. Grass 2.Leaf 4.Crop residue d) other, specify----------
48. How is the trend of livestock productivity?
    1. Increasing 2.Decreasing 3.No change4.Other specify_____
49. Did you sell any of your animals in the year 2007/08? 1) Yes 2) No
50. If yes for what reason you sell? 1. To purchase agricultural inputs 2.To pay taxes and other debts 3. To purchase food 4. To cover social obligations 6.to purchase farm oxen 5. Others (specify)_____
51. What are the major livestock production constraints in the area?

Livestock production constraints	Rank
Repeated drought	
Animal diseases	
Feed Shortage	
Ingression of thorny weeds	
Economic dearth	
Other (specify)	

Part V. Food shortage and coping Strategies

52. What are the major food sources (supply) for household? (Rank) 1.Own production 2.purchase from market 3.food from food aid 4.gift 5.other (specify) _____
53. What do you think are the main causes of food deficit in the area in order of importance?

Cause of food deficit	Rank
Soil erosion	
Insect or pest infestation	
Shortage of cultivated land	
Poor quality of land	
Erratic rainfall	
Animal disease	

Poor health situation of the farmers	
Drought	
Others (specify)	

54. During which months are food shortages sever?

Months	Degree of severity of food shortage		
	None	Less	Severe
September			
October			
November			
December			
January			
February			
March			
April			
May			
June			
July			
August			

55. How did you cover (cope) the deficit to have enough food? Rank the most frequent five strategies according to their priority.

No	Coping strategies	Yes	No	No	Coping strategies	Yes	no
1	Reduce the number of meals			8	Migrate to work		
2	Ate less preferred food			9	Sale of fire wood		
3	Ate wild food			10	Sold livestock		
4	Children discontinued school			11	Purchased food on cash		
5	Borrow food/money from relatives			12	skip days without eating		
6	Sold seeds meant for planting			13	Received relief food aid		
7	Worked as a daily laborer			14	Others specify		

Part IV. Land degradation (Soil erosion) and Land Security

56. Do you perceive land degradation problem in your in your farmland? 1. Yes 2.No
57. Has land degradation affected your food security status?1. yes 2.No
58. If yes, would you please tell us the forms of land degradation according to their severity levels?

forms of land degradation	Rank
Soil erosion(reduce soil depth)	
Change in soil structure (rockiness)	
Decline in soil fertility	
Decrease in plant cover	
Water logging	

59. If soil erosion is a major land degradation problem in your farm area would you tell us the main causes for such hazards? (Please Rank the possibilities)

Causes of Soil erosion	Rank
Over grazing	
Ploughing of steep slopes	
Deforestation	
High rainfall	
Limited use of soil conservation activities	
Continuous cultivation	
Other (specify)	

60. Do your farmland plots susceptible to erosion? 1. Yes 2. No
61. How many of the farmland plots are susceptible to soil erosion?

How many of your farmland plots vulnerable to erosion?	Number of plots vulnerable to erosion		
	Very vulnerable	**Moderately vulnerable**	**Less vulnerable**

62. How is the extent of soil erosion over time?
    1) Increasing 2) Decreasing 3) No change
63. What type and extent of soil erosion occurs in your farmland?

Do you observe the following erosion types in any of your farmland?	**Put (√)**	
	Yes	**No**
Runoff (overland flow)		
Sheet erosion		
Rill erosion		
Gully erosion (deeper than 50 cm)		
Other (specify)		

64. Do you think food shortage has effect on land degradation?
65. What is the major effect of soil erosion on your farmland?
    1. Demand more labor for farm activity 3. Leading to reduced crop yield
    2. Farmland become out of production 4. Make the soil less fertile
    5. Other specify_____
66. What is the extent of erosion impact on your crop yields?
    1. Very severe 2. Severe 3.Moderate 4. Has no effect
67. How serious is the decline in soil fertility, on your main plot, since you started farming? 1. Very severe 2.Severe 3.Moderate 4.Has no effect
68. If your answer to the question 64 is severe/very severe, what did you do to improve the status?
    1. Use manure 2.Add chemical fertilizer 3. Rotate crops 4.Use compost
    5. Leave as fallow land 6.Other Specify_____
69. Have you ever constructed any type of SWC technology in your farm plot/s?
    1. Yes 2. No
70. If yes, what is the type of the SWC you constructed?
    1. Traditional (earth bund) 2. Modern (stone or/and soil terrace)
    3. Cut of drain 4.Trench 5.Other specify_____
71. If the answer for (Q. 70) is no what is/are your reason?_____
72. Do you expect land redistribution in the future? 1. Yes 2. No
73. Do you perceive a risk of loss of your farmland plots in the future? 1. Yes 2. No

Part VII Agricultural Extension services (SWC)

74. Have you received any type of extension service in the year 2007/8?
    1 Ye s 2. No
75. Do development agents visited your farm during the year 2007/8? 1. Yes 2. No

76. If your answer to Question 75 is Yes, How frequent was the visit? 1. Once in a week 2.Once in two weeks 3. Once in a month 4.other (specify)_____
77. Have you participated in soil and Water conservation trainings?1.Yes 2.No
78. Have you get any training in preparing of manure or compost?1.Yes 2.No

Part VIII. Credit services

79. Have you received any type of credit in the last three year? 1. Yes 2. No

If yes, would you please give us the following details?

Purpose for credit	**Total Amount Birr**	**Source**

80. What are the major credit service problems? **Rank**_____1. Loan is not timely available 2.Repayment term are not favorable 3.Pay back period is short 4. High interest rate 5. Absence credit service 6. Others (specify)

Part IX. Productive Safety net

81. Have you participated in the safety net program? 1. Yes 2.No
82. If your answer to (Qn. 80) is yes, in which of the following activities you involved? 1. Construction of communal land SWC 2. Construction of Roads
    3. Development of water supply and sanitation 4.other (specify)

Part X. Marketing

83. Where do you sell your farm products? (Multiple answer possible)
    1) On farm (local assembler) 2) Taking to the local market
    3) Through service cooperatives 4) others (specify)
84. What is the nearest distance to sell your farm products? _____
85. Have you faced any price change in the food shortage period? 1.Yes 2.No
86. What major market problem you observe in your area? Rank _____

Market problem	**Rank**
Markets far away from villages	
Post-harvest price drops	
Inadequate transport facility	
Taxation of agricultural products	
Unstandardized units of measurement at the market places	
High food price in the market during food deficit season	
Other (specify)	

Part XI. Food consumption during last 14 days *(for the person responsible for food preparation)*

87. List down food consumption during last 14 days

List of food items consumed in the last 14 days	Unit	Purchased food in (Kg)	Own production(Kg)	Total quantity consumed
Cereals				
Barley				
Besso				
Genfo				
Kollo				
Amiza				
Injera				
Kitta				
Wheat				
Amiza				
Dabo				
Nifro				
Kitta				
Genfo				
Injera				
Teff				
Injera				
Amiza				
Kita				
Field pea				
Nifro				
Wet				
Sorghum				
Injera				
Nifro				
Kita				
Genfo				
Haricot Bean				
Nifro				
Wet				
Safflower *Wet*				
Sesame *Wet*				
Noug *Wet*				
Chick pea				
Kollo				
Livestock product				
Meat				
Milk and milk products				
Egg				
Vegetables				
Onion				
Cabbage				

Potato				
Tomato				
Other food item				

Appendix 7 Checklist for Informal survey

Key informant interview and discussion:-

In depth discussion is made on general and specific aspects of the farming systems of Sekota *woreda* with the staffs of Agricultural and Development office, Sekota Dry-land Agricultural Center and elderly farmers. With the major emphasis on the following issues.

1. Let's discuss the following issues
   - the **extent** of land degradation
   - major **forms** of land degradation
   - major **causes** of land degradation
   - the **perception level of farmers** about land degradation
   - the **response of farmers** to land degradation.
2. Let's discuss what is food shortage means to you? What are the major causes? How households cope with the problem?
3. How is the trend of crop production and livestock productivity in the area in general? 1) Increasing 2) Decreasing 3) No change. Discuss, What are the major causes?
4. Discuss how land degradation (soil erosion) relates with household food production.
5. Discuss how land degradation (soil erosion) relates with household income.
6. How do you see the safety net program and other food security programme?
7. What is your comment concerning the **planning, designing and implementation** of the safety net program strategies (e.g. resettlement) in the *woreda*?

Thank you!!!

DECLARATION

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any University and that all sources and that all sources of material used for the thesis have been duly acknowledge.

Declared by:

Name: Lepuru Julia

Signature:

Date: 22/07/08

Place:

This thesis has been submitted for examination with my approval as a University advisor

Name:

Signature:

Date:

Place: