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Impact of Mai Nugus Irrigation Scheme on Household Food Security:

A Case Study in Laelay Maichew Woreda, Central Zone of Tigray, Northern Ethiopia

M.A. Thesis

BY:

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Declaration

I hereby declare that the Dissertation entitled ‘’ Impact of Mai Nugus Irrigation Scheme on Household Food Security: A Case Study in Laelay Maichew Woreda, Central Zone of Tigray, Northern Ethiopia ’’ submitted by me for the partial fulfilment of the requirements for the Degree of Master of Arts in Rural Development (MARD) to Indira Gandhi National Open University (IGNOU) New Delhi is my own original work and has not been submitted to IGNOU or other Institutions for the fulfilment of the requirements of any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from earlier works.

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Certificate

This is to certify that Girmay Gebremichael student of M.A from Indira Gandhi National Open University (IGNOU) New Delhi was working under my supervision and guidance for his thesis work entitled '' Impact of Mai Nugus Irrigation Scheme on Household Food Security: A Case Study in Laelay Maichew Woreda, Central Zone of Tigray, Northern Ethiopia'' which he is submitting is his genuine and original work.

Place: Addis Ababa Signature_____

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LIST OF ACRONYMS

ADLI	Agricultural Development Led Industrialization
DPPA	Disaster Prevention and Preparedness Authority
DPPC	Disaster Prevention and Preparedness Commission
FDRE	Federal Democratic Republic
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
HA	Hectare
IWMI	International Water Management Institute
KM	Kilometer
LIMDEP	Limited Dependent Variable
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
NGOs	Non Governmental Organizations
O&M	Operation and Maintenance
OIDA	Oromiy Irrigation Development Authority
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
RDA	Recommended Daily Allowance
RRC	Relief and Rehabilitation Commission
UN	United Nations
UNDP	United Nations development Program
UNFPA	United Nation Fund for Population Activities
USAID	United States Agency for International Development
USD	United States Dollar
WSDP	Water Sector Development Program
WUA	Water Users Association

BIOGRAPHY

The author was born from his father Ato Gebremichael Getahun and his mother W/ro Tadelech Meresa in Mekele in 1970. After he completed his primary and secondary school, he joined Alemaya University of Agriculture in 1993 and graduated with B. Sc. degree in Plant Sciences in 1996. Thereafter he was employed in the Commission for Sustainable Agriculture and Environmental Rehabilitation Tigray (CO-SAERT) in Mekele in 1996, as an Agronomist and Soil expert; in 2002 the author joined Adigrat Diocese Catholic Secretariat (ADCS) in Mekele as Agriculture and Natural Resources Project Officer. The author then joined the United Nations World Food Programme (UN WFP) in 2006 and is working in this organization as Field Monitor Assistant in the programme unit.

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ABSTRACT

Ethiopian agriculture is largely small scale subsistence oriented and crucially dependent on rainfall. Although irrigation is one means by which agricultural production can be increased, irrigated production is far from satisfactory in the country. The aim of this study is to analyze the impact of small scale irrigation on household food security and also to describe the management systems of the schemes. The study was conducted in Laelay Maichew district on three peasant associations namely Dura, Debre Birhan and Medego. Data was collected on 236 household heads and 135, 49 and 52 households were interviewed from Dura, Debre Birhan and Medego respectively.

The study concluded that small scale irrigation is one of the viable solutions to secure household food needs in the study area. The study also suggested the proper management system of the irrigation schemes in order to sustainably use them.

Chapter one: Introduction

This part comprises of four sections. Section 1.1 is the **background of the study** in which facts about agricultural production, food security and small scale irrigation in the country are discussed. Section 1.2 addresses the **statement of the problem** which describes the problem the country in general and the study area in particular are facing and the intention of the study. Section 1.3 deals with the **hypothesis and research question** while section 1.4 indicates **objectives of the study.**

Moreover, section 1.5 deals with the scope of the study its geographical coverage. The last section, 1.6 highlights **significance of the study** in essence it indicates how this study contributes to sustainable improvement of household food security and better management of small scale irrigation systems and also addressing the government strategy of poverty reduction.

1. 1. Background of the Study

Water is difficult to create or destroy under most natural conditions. Thus, the total amount of water on earth today is nearly the same as it was millions of years ago (Seckler, et al., 1998). But with the ever-increasing human population, global demand for water is steadily increasing. So, it becomes questionable whether many countries, especially poor developing ones, would be able to meet their water needs in the next decades. Though the earth is assumed to have enough water to support its population this remains more theoretical, because much of it is not available in the quality and quantity we demand. The use of water is multidimensional and indispensable for the very existence of humankind.

Paradoxically, it is widely debated that many countries are entering an era of severe water shortage, of which Ethiopia is no exception (Getachew, 1990). During the twentieth century, human population tripled and water use increased six-fold mostly for agricultural use (Berhanu and Peden 2002). Demand for water in Africa has grown rapidly, at 3.5% per year since 1970, much higher than the world average of 2.4% and in the continent, agriculture accounts for about 85% of water withdrawals (i.e. the share of agriculture from the total amount of water used by different sectors) though the physical irrigation potential is far from being tapped (Rosegrant and Perez, 1997). It is estimated that only about one third of the potentially irrigable land is under irrigation in the continent . Accordingly, water is one of the

crucial resources, which plays a critical role in the sustainable livelihoods of rural people. Improvements in access to water serves as a powerful tool to diversify the source of income of households and reduce vulnerability of small producers, creates options for extended production across the year, increases yields and outputs, and creates employment opportunities (ibid).

Agricultural productivity has risen sharply in recent decades due to higher yielding varieties, increased fertilizer use, and major investment in water resources infrastructure. Investment in many billions of dollars in irrigation infrastructure has been the key component of the Green Revolution (Rosegrant and Perez, 1997). In Sub Saharan Africa, inadequate growth in food production and increasing water scarcity pose serious challenges to future agricultural and economic development. Moreover, semi arid and arid areas are home to about one-six of the world's population (ibid).

Like many least developed countries (LDCs) Ethiopia's economy is predominantly agrarian. Though the majority of the working force is engaged in agriculture, increasing food insecurity and hunger has been a rule than the exception in Ethiopia. Agricultural and factor productivity (of land, labour, etc.) is extremely low. The expected backward and forward linkages have been week for agriculture to be the engine of economic growth. Low productivity and the drive for survival led to severe degradation of the resource base reinforcing the negative environmental effects. This was exacerbated due to policy neglect to peasant agriculture and unreliable weather conditions (Berhanu and Peden, 2002).

Water harvesting is considered as the single most important means to increase agricultural productivity and provide a source of drinking water in drought prone areas such as Tigray. This makes cultivation of crops twice or more a year possible besides the possibility for supplementary irrigation when rains stop early. Farmers may also shift to high value crops with increased likelihood of using improved inputs due to reduced risk of crop failure and increased yield due to input complementarities. Given the availability of reliable marketing opportunities and other supporting services (e.g. credit, extension), these may lead to higher income for farm households. Furthermore, this may have direct effect on household welfare in terms of improved nutrition due to improved dietary intake because of demand (due to increased income) and supply effects (due to increased growing of vegetables and fruits on home gardens). Besides, the overall increase in income and household welfare may lead to investment on land thereby contributing positively in reversing the spiral of poverty-induced environmental degradation (ibid).

In spite of all these efforts and commitment of huge resources to construct all these physical water harvesting structures, there is limited effort to quantify the impact of these interventions on household welfare, food security and resistant to drought and asset building. There is also a serious paucity of data on whether such small scale irrigation schemes are contributing to improvements in household welfare and food security. The objective of this study is, hence, to explore the impact of small scale irrigations scheme on household food security.

Ethiopia a country located in Eastern Africa has a population of about 70.6, million which is projected to reach 106 million in the 2020. Its total land area is 1093 million hactares. The history of water harvesting in the country dates as far back as the pre Axumite period (1560 BC). During the Axumite period, rainwater was harvested and stored in ponds for agricultural and other purposes. Moreover, the Konso people in the southern part of the country have established tradition of building level terraces to harvest rain water to successfully produce crops under extremely harsh environment, low, erratic and unreliable rain fall conditions (Getachew, 1999).

However, modern water development in Ethiopia started during the Imperial regime in the 1950s, with large-scale irrigation schemes and hydroelectric power projects. These developments were concentrated in the Awash valley as part of the agro-industrial development initiative, which gradually expanded to the rift valley and the Wabe Shebele basin. At the beginning of the 1970s, about 100,000 hectares of land was estimated to be under modern irrigation, 50% of which was in the Awash valley (Berhanu and Peden 2002). In the 1980s, thousands of irrigated land in the Awash Valley was out of production due to salinity and water logging, which resulted due to managerial and operational problems. In general, as pointed by Dessalegn (1999) the lessons taken from the experiences and failures of irrigation development during the imperial regime and military regimes which focused on large scale irrigation and high technology water projects is the need for a pluralistic approach to water development and active involvement of beneficiaries in the design, and implementation of water development projects, and management of operational schemes. In essence, the pluralistic approach would have benefited small-holders better and contributed to the national food production, which the previous two regimes lacked it.

Most areas in the Northern highlands of Ethiopia, where large number of people live, are drought prone and moisture stress. The mean annual rainfall in the Ethiopian highlands ranges between 400 and 1300 mm, which vary widely across the country. Most parts of the Northern highlands of the country, including Tigray (in general and the study area in particular), experience perpetual droughts (Kinfe, 2002).

In tropical agricultural system, like Tigray region, where evapo-transpiration is high, much of these small amounts of annual rainfalls will escape back to the atmosphere before growing plants have used it. In addition, the amount of annual rainfall fluctuates from year to year. This implies that high variability of year-to-year occurrence of rainfall and less reliable for crop growth especially for those which are sensitive to moisture stress. Sometimes rain comes early or late to the growing period of crops and this causes crop failure (ibid).

The current economic policy of Ethiopia has aimed at two main issues: rapid and sustainable development and fair distribution of development benefits among citizens. The main strategy adopted to realize this policy is Agriculture Development Led Industrialization (ADLI), MoFED 2002.

1.2. Statement of the problem

'Chronic food insecurity' (continuous inadequacy of diet resulting from lack of resources to produce or acquire food) and 'transitory food insecurity' (a temporary decline in a household's access to enough food) were mainly prevalent in northern and eastern parts of the country. But recently, food insecurity has expanded to other parts of Ethiopia causing the drought related famine to increase in frequency, intensity and number of affected population. The factors that have contributed to such deteriorating situation may vary from region to region or from one locality to another. Lack of rainfall, fragmented landholdings, dominance of subsistence production units, low adoption of improved production inputs and techniques, incidence of pests and diseases, dependence on rainfall (low irrigation development) and inappropriate policies are among the major threats of the country's agricultural development and food security both at national and local levels (Adnew 2004).

Some studies show that more than 90% of farmers in Tigray produce insufficient food for household subsistence, implying that these households are food insecure (Kinfe, 2002). On the other hand, as the

rain fed agricultural calendar ranges mainly from June to November, farmers remain idle for the rest of the year, as the land remain uncultivable due to lack of water.

Although the rainfall distribution is as mentioned in the background, agriculture depends entirely on a seasonal rainfall, which is erratic, showing high variability in both spatial and temporal distribution. Due to such reasons, agricultural production is also highly variable, showing high variability in yield every year. As a result, the region has remained food deficient and historical data confirms the gap between required and produced food, which in the later years becomes wider, as per the short rainy season crop production assessment, a large number of people depend on relief food from three to nine month (ibid).

Accordingly, since lack of food security is a major challenge for attainment of sustainable socio-economic development, water harvesting and intensification of small-scale irrigation is being emphasized as a means of increasing agricultural production and food security in the region and the country at large to ensure food security for people living in drought-prone areas. The source of water for small scale irrigation can be dams, river diversions, ponds and spring development. The main advantages of the small scale irrigation projects lay in their short gestation period that result in quick impact, lower capital requirements, in the scope they provide for people's participation and their relative ecological friendly nature (Shylendra and Ballabh, Unpublished).

Today, water harvesting through the construction of micro-dams and river diversion for the development of small-scale irrigation is a priority agenda of the Federal Government of Ethiopia, as well as the Regional Government of Tigray. So far, the acheivements made in constructing micro dams and river diversion and in giving access to small-scale farmer irrigators are enormous. Above all, these efforts indicate the commitment of the Government to use every available means to develop water resources to improve the food security situation in the region. The initiatives are also supported by indigenous NGOs engaged in the development and use of small-scale water harvesting schemes for both household and agricultural uses. This has been designed as a strategy towards enhancing food security at household level.

Another problem related to annual rainfall distribution is that, many of the cereal crops in the highlands of Tigray require more than 90 days of growing season, i.e., for vegetative and flowering periods, but

effective rainfall distribution in this region is concentrated only in almost 60 day. This again implies that the rainfall distribution in the highlands of Tigray, for those crops, which require more than 60 days of growing period, is less reliable. Crops are grown once in a year and agricultural intensification by applying external inputs such as chemical fertilizer is totally impossible with this scant and fluctuating rainfall distribution. Currently, farmers are not willing to invest in external input due to unreliable rainfall amount and distribution. This is to avoid risk in their investment (personal communication with farmers).

Moreover, since the farming system of highland Tigray is mixed farming, for much of the time land will be dry and there will not be enough supply of feed for livestock and in some areas, for watering of animals they have to travel for half a day. On the other hand, livestock are important assets and source of cash income of the rural poor. Thus, improved feed availability increases the productivity of livestock and this improves household income and food security. Irrigation can increase livestock feed supply through increased crop residues and relieving the pressure on grazing lands.

Irrigation can also increase the productivity of grazing lands themselves if water is used for producing animal feed directly, thus allowing crop residues to return to the soil to maintain soil fertility. This makes it important to fix methods that increase the inter temporal efficiency of water use. Appreciating such a gap, the intensification of small-scale irrigation is now becoming one of the most important tools that Ethiopia should give priority as a means of poverty reduction and maintaining food security. Thus, the importance of water harvesting in the country is acknowledged not only for supplementary irrigation, which is the main focus in many areas, but also for livestock, domestic and other productive purposes. Above all, small-scale irrigation as a means of food security and poverty reduction is highly important in moisture stress areas where Tigray could be a good example.

1.3. Hypothesis and Research Question

Hypothesis

Development of small scale irrigation schemes has a significant role in improving the food security situation of project beneficiaries.

Main questions

The main questions of the research are stated below:

- How did the project contribute to food security of the target community in general and households in particular and how sustainable are the out puts?
- Does lack of rainfall for a season result in a profound disorder of people's way of life?
- Has the project intervention really brought an effect in breaking up the deep-rooted food in-security? Is it worth to scale up as 'a success story'?
- Is the improvements brought by the project intervention in the area sustainable?

- Did the project intervention on spate irrigation development improve the community and households food production?
- To what extent has the project achieved its intended results?
- What are the major assets built due to the project intervention?
- To what extent has the project built the capacity of community towards sustainable management of its out puts?

1.4. Objectives of the study

Cognizant of the fact that Ethiopia can not hope to meet its large food deficits through rainfed production alone, the government has already taken initiatives towards developing irrigation schemes in different parts of the country. Laelay Maichew district is one of the places where small scale irrigation is being practiced. However, there is no adequate study to scrutinize the extent to which these small scale irrigation schemes are contributing towards household food security. Besides, their management system towards sustainable development is not fully assessed. Therefore, this study has one general objective and four specific objectives:

1.4.1. General objective

The general objective of the research is to assess the impact of an Irrigation scheme on the improvement of sustainable food security.

1.4.2. Specific objectives of the study

More specifically, the overall emphasis of the research will be:

- To examine whether the project has improved or not the food security situation of the target community and households;

- To identify the physical, social, economic and institutional factors that positively or adversely affect the sustainability of project outputs;

- To assess the project intervention impact in breaking up the deep-rooted food in-security;

- To determine the sustainability of the project in the improvement of livelihood of the target community.

1.5. Scope of the Study

The study focuses on assessment of the impact of small-scale irrigation on household food security and its management system. This study is limited to only one district because of the limited time and resource. The district where the study was conducted is Laelay Maichew. It is found in the Central Zone of Tigray Regional State. This district is selected because of its accessibility and availability of better irrigation practice.

1.6. Significance of the Study

The national development plan of the country is based on a strategy called "Agricultural Development-Led industrialization and aims at reducing the country's dependence on rain-fed agriculture and associated food insecurity by boosting agricultural productivity and improving the rural standard of living, which in turn will increase the demand for goods and services and further lead to industrial development. Central to achieving the agricultural development policy objective is the promotion of irrigated agriculture (MoFED, 2002).

Ensuring an adequate and reliable supply of irrigation water is presumed to increase yield of most crops. Along with higher yields, irrigation also increases incomes and reduces hunger and poverty. Where irrigation is widely available under nourishment and poverty are less prevalent. Even landless laborers

and small holder farmers who lack the resource to employ irrigation themselves often benefit through higher wages, lower food prices and a more varied diet (FAO, 2003).

To this end, identifying, analyzing and understanding the impact of small scale irrigation on household food security and assessing the management of small scale irrigation schemes would contribute to the sustainable improvement of household food security, better management of small scale irrigation systems and executing the government strategy of poverty reduction.

Chapter two: Literature Review

2.1. Definition of terminology and concepts

2.1.1. Definition of irrigation

Irrigation is much discussed but seldom clearly defined. It may mean frequent and regular application of water, to others as little as one annual watering. A wide definition such as the following is, therefore, more useful. Irrigation is the practice of applying water to the soil to supplement the natural rainfall and provide moisture for plant growth (Uphoff, 1986).

2.1.2 Definition of a household

Callens and Seiffert (2003) defined a household as a unit of people living together headed by a household head. This is often a man or a woman, in case there is no man. Increasingly, grand parents are taking up this role, as well as adolescents, in those households where both parents have deceased. Apart from the head of the household, there may be a spouse, children and permanent dependants like elderly parents or temporary dependants like a divorced daughter or son.

Ellis (1993) defines a farm household as an individual or a group of people living together under one hearth deriving food from a common resource, obtained mainly from farming activities.

In this study a household is considered as a unit of people living together headed by a household head. This may be a man or a woman incase there is no man. Increasingly, grand parents are taking up this role, as well as adolescents, in those households where both parents have deceased. Apart from the household head, there may be a spouse, children and permanent dependants like elderly parents or temporary dependants like a divorced daughter or son who derives food from a common resource, obtained mainly from farming activities.

2.1.3. Definition of food security

Food security is defined by different agencies and organizations differently without much change in the basic concept. UN (1990) defines household food security as “The ability of household members to assure themselves sustained access to sufficient quantity and quality of food to live active healthy life.” Food security can be described as status in which production, markets and social systems work in such a

way that food consumption needs of a country and its people are always met. FAO (1992) defines food security not only in terms of access to, and availability of food, but also in terms of resource distribution to produce food and purchasing power to buy food, where it is produced.

USAID (1992) defines food security as: "when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life." Here food security includes at a minimum the availability of nutritionally adequate and safe food, and assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

One of the most influential definitions of food security is that of the World Bank (1986). The Bank defines it as "access by all people at all times to enough food for an active and healthy life." This definition encompasses many issues. It deals with production in relation to food availability; it addresses distribution in that the produce should be accessed by all; it covers consumption in the sense that individual food needs are met in order for that individual to be active and healthy. The availability and accessibility of food to meet individual food needs should also be sustainable. This implies that early warning systems of food insecurity should monitor indicators related to food production, distribution, and consumption.
Among the various definitions of household food security, this study adopted the definition given by the World Bank.

Often, the term household food security and 'food security' are intermingled. Food security is defined in its basic form as access by all people at all times to the food needed for a healthy life. The focus in 'household' food security is on the household as the most basic social unit in a society. The distinction between food security and household food security is important because activities directed towards improving household food security may be quite different from those aimed at improving national level food security. The latter often related to macro-level production, marketing, distribution and acquisition of food by the population as a whole (FAO, 2003).

The focus in household food security is on how members of a household produce or acquire food through out the year, how they store, process and preserve their food to overcome seasonal shortages or

improve the quality and safety of their food supply. Household food security is also concerned with food distribution within the household and priorities related to food production, acquisition, utilization and consumption.

The generation of household food security is dependent on the physical availability of food at the market or community level, the ability of household to access the available food, the ability of individuals-particularly those especially susceptible to food deficits such as women, infants and children-to eat the food, and finally the body's ability to process the nutrients consumed (Bouis and Hunt, 1999). The assessment of food security extends to consider the health of those eating the food-the objective is a healthy and active life. Here nutritional consideration begins to come to the fore (Benson, 2004). Nutrition security is defined as the appropriate quantity and combination of inputs such as food, nutrition, health service and caretaker's time needed to ensure an active and healthy life at all times for all people. The quality of food to which an individual or household has access must be considered. To enjoy a productive, healthy and active life, all people require sufficient and balanced level of carbohydrate, protein, fat, vitamin and minerals in their diets. Households or individuals facing deficiencies or other imbalances in diet because they lack access to the necessary food for balanced diets are not food secure (Benson, 2004).

2.1.4. Core Concepts in Household Food Security

The many definitions and conceptual models all agree that the key defining characteristic of household food security is secure access at all times to sufficient food.

2.1.4.1. Sufficiency: What is "Enough?"

The concept of "enough food" is presented in different ways in the literature: as a minimal level of food consumption, as the food adequate to meet nutritional needs. In more descriptive formulations, it refers to enough (food) for life, health and growth of the young and for productive effort, enough food for an active, healthy life and enough food to supply the energy needed for all family members to live healthy active and productive lives. From these definitions, four aspects of the question can be distinguished (Maxwell and Frankenberger, 1992).

First the unit of analysis in these definitions is the individual, not the household. Where the household refers to an aggregation of individuals whose food needs must be satisfied.

Secondly, although the definitions mostly refer to "food'' the main concern is with calories not with protein, micro-nutrients, food quality and safety. This is mainly because analysts operate on the principle that other needs are usually satisfied when calorie intake is satisfactory. Because it is difficult to estimate precise calorie needs for different groups in the population, it is concluded that all estimates of nutritional requirements have to be treated as value judgments. Finally, although the difficulty of measurement, an important aspect of assessing whether people have access to "enough" food is to ask how far they fall below the threshold. In the earlier literature on malnutrition and in the current literature on poverty, the size of the gap is an important theme.

2.1.4.2. Access and entitlement

Access to food is necessary but not a sufficient condition for a healthy life. A number of other factors such as health, sanitation and household and public capacity to care for vulnerable members of society also come in to play (Von Broun et al., 1992).

Food access is ensured when households and all individuals within them have adequate resources to obtain appropriate food for a nutritional diet. Access depends up on income available to the household, on the distribution of income within the household and on the price of food. Accordingly, household food access is defined as the ability to acquire sufficient quality and quantity of food to meet all household members' nutritional requirements for productive lives. Food access depends on the ability of households to obtain food from their own production, stocks, purchases, and gathering or through food transfers from relatives, members of the community, the government, or donors (FAO, 2003).

A household's access to food also depends on the resources available to individual household members and the steps they must take to obtain those resources, particularly exchange of other goods and services (Bilinsky and Swindale, 2005). Access to different resources and the pattern of social support have greater impact on the procurement strategies of food supplies. The basic resources like cash, labor, land, markets and public services determine the possibility of increasing entitlement to food. These are the key factors for either promoting food security or increasing vulnerability to food insecurity (Debebe,

1995). Sen (1981) also argued that mere presence of food in the economy or in the market does not entitle a household or a person to consume it. According to the same study people usually starved mainly because of lack of the ability to access food rather than because of its availability. In a sense, income or purchasing power is the most limiting factor for food security. In many ways the antithesis of food security is famine. The key elements that determine successful food security, food availability, access and use are the outcome of multiple processes of food supply, marketing and demand operating at both national and household level. By contrast, the major symptoms of famine-resource base depletion, social and economic dislocation (community break up, market and institutional failure), and human mortality-derive from the failure of many of the processes and events (Webb and Braun, 1994).

2.1.4.3. Security

The third main concept is that of "security", that is, secure access to enough food. This builds on the idea of vulnerability to entitlement failure, focusing more clearly on risk. It is necessary to identify the risks to food entitlements. These can originate from many sources and include variability in crop production and food supply, market and price variability, risks in employment and wages and risks in health and morbidity. Conflict is also an increasingly common source of risk to food entitlements (Maxwell and Frankenberger, 1992).

According to Sen (1981) risks to food entitlement could originate from a number of sources such as: weather variability, food production and supply variability, variability in price and market, health hazard and morbidity causing risks, employment and wage variability. In general, it could be environmental, natural, political, social, cultural and economic risks.

2.1.4.4. Time

Finally we come to “time", that is, secure access to enough food at all times. The topic is not much discussed in the literature. However, following the lead of the World Bank (1986) it has become conventional to draw distinction between chronic and transitory food insecurity.

Chronic food insecurity means that a household runs a continually high risk of inability to meet the food needs of household members. In contrast, transitory food insecurity occurs when a household faces temporary decline in the security of its entitlement and the risk of failure to meet food needs is of short

duration. Transitory food insecurity focuses on intra and inter-annual variations in household food access. This category can be further divided in to cyclical and temporary food insecurity. Temporary food insecurity occurs for a limited time because of unforeseen and unpredictable circumstances. Cyclical or seasonal food insecurity occurs when there is a regular pattern in the periodicity of inadequate access to food. This may be due to logistical difficulties or prohibitive costs in storing food or borrowing (Maxwell and Frankenberger, 1992).

Food security in general is a concept, which integrates a number of important issues the magnitude of which ranges from micro to macroeconomics. Its attainment involves overall considerations in terms of policy and program development in all aspects of the food system. Hence, the success in production and distribution plays an important role in influencing the food security status of an individual or a society at large (Debebe, 1995).

2.1.5. Indicators of Household Food Security

Along with the development of the concept of food security, a number of indicators have been identified to make monitoring of food situation possible. Their utilization varies between the characteristics of the investigations, procedures and level of aggregation. In most cases, the purpose and depth of investigations highly influence the use of indicators, in some early warning systems, for example, three sets of indicators are often used to identify possible collapses in food security. These include food supply indicators (rainfall, area planted, yield forecasts and estimates of production); social stress indicators (market prices, availability of produce in the market, labor patterns, wages and migration) and individual stress indicators (which indicate nutritional status, diseases and mortality). These indicators are important to make decisions on the possible interventions and timely response (Debebe, 1995).

Chung et al. (1997) identified and proposed two types of indicators at individual and household level. First, generic indicators are those that can be collected in a number of different settings and are derived from a well-defined conceptual framework of food security. Second, location specific indicators are those indicators typically carried only within a particular study area because of unique agro climatic, cultural, or socioeconomic factors. Location-specific indicators can be identified only from a detailed understanding of local condition by using qualitative data collection methods, while the generic indicators are drawn from the food security literature and tested using statistical methods.

The different types of indicators, however, are classified into two main categories; 'process' and ' out come' indicators. The former provides an estimate of food supply and food access situation and the latter serves as proxies for food consumption (Frankenberger, 1992).

2.1.5.1. Process indicators

Process indicators are divided in to two: indicators that reflect food supply and indicators that reflect food access. Indicators that reflect food supply: One critical dimension of household food security is the availability of food in the area for the households to obtain. Regional food shortages have a strong influence on household food availability. A number of factors play a role in limiting food availability and the options households have for food access. These are indicators that provide information on the likelihood of a shock or disaster event that will adversely affect household food security. They include such things as inputs and measures of agricultural production, food balance sheet information, and access to natural resources, institutional development, market infrastructure and exposure to regional conflicts or its consequences.

These types of indicators are not mutually exclusive of food access indicators, and considerable overlap and interaction between the two categories may exist (Frankenberger, 1992).

Indicators that reflect food access: unlike supply indicators, food access indicators are relatively quite effective to monitor food security situation at a household level. Their use varies between regions, seasons and social strata reflecting various strategies in the process of managing the diversified source of food that shift to sideline activities, diversification of enterprises and disposal of productive and non productive assets (Debebe, 1995).

2.1.5.2. Outcome indicators

Outcome indicators are used to measure the status of food security at a given point in time. Household food security outcome indicators can be grouped into direct and indirect indicators. Direct indicators of food consumption include those indicators which are closest to actual food consumption rather than to marketing channel information or medical status. Indirect indicators are generally used when direct indicators are either unavailable or too costly in terms of time and money to collect. Some of the direct indicators include: household budget and consumption surveys, household perception of food security

and food frequency assessment. The indirect indicators include storage estimates, subsistence potential ration and nutritional status assessment (Frankerberger, 1992).

2.1.6. Measuring Household Food Security

Using the available data, food security measurement can be estimated through several feasible methods. In this study the food energy intake method by Greer and Thorbecke (1986) was employed for ease of computation. What the food energy intake method is aiming to do is find a monetary value of the poverty line at which "basic needs" are met. Food energy intake will naturally vary at a given expenditure level. Recognizing this fact the method typically calculates an expected value of intake. To obtain the estimated cost of acquiring the calorie recommended daily allowance (RDA) that is, 2200 kcal per adult equivalent per day, this method regresses food energy intake (calorie) against total food expenditure per adult equivalent per annum. Accordingly, birr 990 was found to be the minimum food expenditure per adult equivalent per annum required to meet basic needs (calorie recommended daily allowance). In this study food expenditure data was collected on a monthly basis, however, in order to calculate the food expenditure the data was caled up to yearly basis. The detail steps followed is indicated in appendix I.

At the household level, food security is measured by actual dietary intake of all household members using household income and expenditure surveys (Saad, 1999). Using a survey data the minimal standard of living is proxy by the level of consumption expenditure that will enable the household or individual to attain the basic needs. This usually refers the ability of the household to purchase a basket of goods containing the minimum quantity of calories and non-food commodities. Households who are not able to achieve this critical level of consumption expenditure or income can be described as poor (Nsemukila, 2001). Bickel et al. (1998) suggests that household food security can be measured by food poverty indicators and by anthropometric data. A food poverty indicator shows the number of individuals living in a household whose access to food is sufficient to provide a dietary intake adequate for growth, activity and good health. The anthropometric measure refers to nutritional status at individual level. Thus, individual food security implies an intake of food and food absorption of nutrients sufficient to meet an individual's needs for activity, health,growth and development. The individual's age, gender, body size, health status and level of physical activity determine the level of need. Hoddinott (2002) discusses four ways of measuring household food security: individual intakes

(either directly measured or 24-hour recall), household caloric acquisition, dietary diversity and indices of household coping strategies.

According to Hoddinot (2002) individual food intake is a measure of the amount of calorie or nutrients consumed by an individual in a given time period, usually 24 hours. To collect the data an enumerator resides in the household throughout the entire day, measuring the amount of food served to each person and the amount of food prepared but not consumed ("plate waste") is also measured. In addition, the enumerator notes the type and quantity of food eaten as snacks between meals as well as food consumed outside the household. The second method is recall. The enumerator interviews each household member regarding the food they consumed in the previous 24-hour period. This covers the type of food consumed, the amount consumed, food eaten as snack and meals outsides the household. According to the same study the individual food intake method has two principal advantages: implemented correctly, it produces the most accurate measures of individual caloric intake (and other nutrients) and therefore the most accurate measure of food security status of an individual. Second, because the data are collected on an individual basis, it is possible to determine whether food security status differs with in the household. Set against these significant advantages are a large number of disadvantages. These are measures of intakes need to be made repeatedly ideally for seven non-consecutive days. It requires highly skilled enumerators who can observe and measure quantities quickly and accurately. The recall method requires enumerators to interview carefully every household member until they have established the exact make up.

The second way of measuring household food security proposed by Hoddinot (2002) is household calorie acquisition. This is the number of calories, or nutrients, available for consumption by household members over a defined period of time. Here the principal person responsible for preparing meals is asked how much food, she 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. A set of questions regarding food prepared for meals over a specified period of time, usually either 7 or 14 days is asked to the person in the household most knowledgeable about this activity. Hoddinott (2002) states the advantages and disadvantages of the method as follows: the advantage is that, this measure produces a crude estimate of the number of calorie available for consumption in the household. Therefore, the level of skill required by enumerators is less than that needed to obtain information on individual intake. The

disadvantage of the method is that, the method generates a large quantity of numerical data that needs to be carefully checked both in the field and during data entry.

The third way of measuring household food security in the same study is dietary diversity. This is the sum of the number of different foods consumed by an individual over a specified time period. It may be a simple arithmetic sum, the sum of the number of different food groups consumed. To collect data, one or more persons with in the household are asked about different items that they have consumed in a specified period. These questions can be asked to different household members where it is suspected that they may be differences in food consumption among household members. The advantage of this method is that, it is easy to train enumerators to ask these questions and individuals generally found them easy questions to answer. The disadvantage of this measure is that the simple form of this measure doesn't record quantities. If it is not possible to ask about frequency of consumption of particular quantities, it is not possible to estimate the extent to which diets are inadequate in terms of caloric availability. Indices of household coping strategies are the fourth way of measuring household food security in Hoddinott (2002). This is an index based on how households adapt to the presence or threat of food shortages. To generate the data, the most knowledgeable woman in the household regarding food preparation and distribution within the household is asked a series of questions. According to the study there are three attractive features of this measure. First, it is easy to implement, typically taking less than three minutes per household. Second, it directly captures notions of adequacy and vulnerability. Third, the questions asked are easy to understand both by respondents and by analysts. Some disadvantages of this measure are also identified by the same study: as it is a subjective measure, different people have different ideas as to what is meant by “eating smaller portions" comparison across households or localities is problematic. Second, its simplicity makes it relatively straightforward to misreport a household's circumstances. For example, households might perceive that they are more likely to receive assistance when they report greater use of these coping strategies.

Maxwell et al. (2002) states that coping strategy is people’s response to conditions under which they do not have enough to eat. The more people have to cope, the less food secure they are. There are two basic types of coping strategies. One includes the immediate and short term alternation of consumption pattern. The other includes the alternation of income earning or food production. Coping strategy index (CSI) is defined as a numeric measure of household food security status. In order to construct the index

it is important to know how severe each strategy is and to do this, information is collected from community level focus group discussion. To give a quantitative value to the relative frequency, the mid point of the range of days for each category will be taken.

The study by Maxwell et al. (2002) also discussed that the CSI clearly declines with calorie intake, as households become more food secure. Change in the index provides a rapid indication of whether food security is improving or deteriorating. Maxwell et al. (2002) concluded that, the CSI is a good proxy for food intake (calorie adequacy), as well as food share (the proportion of income that households devote to food purchased), food frequency, income status and presence or absence of a malnourished child in the household.

According to a study by Greer and Thorbecke (1986) household food security can be measured by the food poverty line. This is the minimum amount of food an individual must consume to stay healthy. It can be measured in terms of the nutritional characteristics of the foods (eg calorie), the quantity of the food stuffs themselves or the monetary value of the foods. In this method, the minimum food expenditure refers to the expenditure necessary for a person with the accepted and typical regional food consumption pattern to consume a nutritionally adequate diet. Focusing on food poverty allows use of the nutrient recommended daily allowances (RDAs)1 as the basis for setting the food poverty line. Greer and Thorbecke (1986) states that setting the poverty line using the cost of calorie approach is conceptually and computationally simple, does not require an excessive sample size, and does not pre-impose a researcher's or bureaucrat's subjective notion of what constitutes a palatable, but inexpensive diet. In essence, it requires only two-piece of information: calorie consumption Cj and food expenditure variable, Xj. The latter variable measures both purchased food and the imputed value of food consumption out of own production.

$Xj = a+bCj$ (1)

The food poverty line Z is the estimated cost of acquiring the calorie RDA, R.

$Z = e (a+Rb)$ (2)

Where a and b are the coefficient estimates of a and b, respectively from equation (1)

This estimation is based on two fundamental assumptions (1) all individuals face identical price (2) there is a common dietary taste pattern. This study applied the above method in order to measure household food security and to calculate the cut- off point (food poverty line) beyond which a household is food

secure or not. The recommended daily allowance for Ethiopia is 2200Kcal per adult equivalent per day (MoFED, 2002).

2.2. Theoretical review

2.2.1 Rainfed Agriculture

The country has experienced very severe and cyclic droughts that have resulted in famine and loss of lives, of which the Tigray Region is most affected. More than 50% of Ethiopians are poor and 52% of the country's population is food insecure (Christian Relief and Development Association – CRDA, 2001). One of the main reasons for such level of poverty and food insecurity is that agriculture as the backbone of the economy is mainly dependent on unreliable rainfall.

Like other farming community in the country in general and the region in particular, the farming community in the study area mainly depend on rain for crop production. The nature of the rain fall condition in the area is mainly characterized by it erratic nature late on set early cease and with long dry spell period. The mean annual rain fall in the area is 350 to 700 mm. This nature of the rain fall in the area affects crop production. As a result the annual crop production is very low which could not fulfil the demand of the people.

Crop production is dependant on the April to August long rains *(Kiremt*/*kiremti)*. The main crops cultivated are sorghum, teff, *hanfets* (mixed barley and wheat), finger millet, and maize.

Oxen are used to provide draught power for land preparation activities. Both men and women participate in weeding and harvesting. The infertile sandy and clay soils reap modest crop yields.
Erratic rainfall and land degradation present further obstacles to improved food security in the zone. Soil conservation, water harvesting and fertilizer are important to improve production.

2.2.2 Irrigation Agriculture

Irrigation practice in Ethiopia in general and in Tigray region in particular is less developed. For long period of time the water source in different part of the country have not been used for crop production and the area under irrigation was very insignificant. According to Getachew (1999), Ethiopia only utilizes about 0.2 million ha of its 3.5 million ha. of irrigable land. When the gross amount of water

resource in the country is taken in to account, the present water requirement for irrigation (to produce one season crop) is approximately less than 3 percent of the total runoff. However, since this huge amount of water resource is not developed, Ethiopia still remains far from producing enough food. Therefore, these shows that high gross per capita of water does mean nothing in relation to production of food and poverty reduction unless it is utilized.

Accordig to PASDEP /Plan for Accelerated and Sustained Development to End Poverty/ (MOFED VI 2006), small, medium, and large-scale irrigation projects have been completed according to the plan. Available data indicates that by the end of 2004/05, the total size of land developed through irrigation has reached 62,057 hectares. Pre-design studies have been initiated to irrigate 8,293 hectares through small-scale and 9,220 hectares through medium and large-scale irrigation;

2.2.3. History of Irrigation Development

History of irrigation development Irrigation is a very old practice in the world. It is an old human activity and been practiced in some parts of the world for several thousand years. Rice has been grown under irrigation in India and Far East for nearly 5000 years. The Nile valley in Egypt and the plain of Tigris and Euphrates in Iraq were under irrigation for 4000 years (Peter, 1997). Irrigation has formed the foundation of civilization in numerous regions for millennia. Egyptians have depended on the Nile's flooding of the delta for years, this may well be the longest period of continuous irrigation on a large scale. Mesopotamia, the land between the Tigris and Euphrates, was the bread basket for the Sumerian Empire. This civilization managed a highly developed, centrally controlled irrigation system. In that same time frame, irrigation apparently developed in present day China and in Indus basin (Schilfgaarde, 1994).

Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future. It not only raises the yields of specific crops, but also prolongs the effective crop- growing period in area with dry seasons, thus permitting multiple cropping (two or three and some times four crops per year) where only a single crop could be grown. Moreover, with the security provided by irrigation, additional inputs needed to intensify production such as pest control, fertilizer; improved varieties and better tillage become economically feasible. Irrigation reduces the risk of these expensive inputs being wasted by crop failure resulting from lack of water (FAO, 1997).

According to FAO (1997) 30-40 percent of world food production comes from an estimated 260 million ha of irrigated land or one–sixth of the world's farmlands. Irrigated farms produce higher yield for most crops. FAO (2001) also reports that the role of irrigation in addressing food insecurity problem and in achieving agricultural growth at global level is well established. Cleary irrigation can and should play an important role in raising and stabilizing food production especially in the less developed parts of Africa South of the Sahara. Traditional irrigation in Ethiopia is a complement to rain fed agriculture, and the crops grown are often horticultural crops and fruit trees. Peasants have a keen awareness of the benefits of irrigation and are willing to invest their labor in the construction and maintenance of the schemes. In parts of north Shoa, north wollo, east Gojjam and the highlands of Harrarge, the traditional systems still being utilized by peasants date back to the last century. Many of these schemes are managed by elected elders known as "water fathers" or "water judges" and this traditional management system has proved effective in many instances. In some cases, the irrigation schemes are managed by peasant associations. It is thus evident that peasants have proven ability to organize themselves and to manage traditional small scale irrigation systems (Dessalegn, 1999). The development of modern irrigation has relatively recent history in Ethiopia, where as traditional irrigation has been in existence for long periods. Private concessionaires who operated farms for commercial cotton, sugar cane and horticultural crops started the first formal large and medium irrigation schemes in the Awash Valley (MoA, 1993).

In Ethiopian context, irrigation systems are classified on the basis of size. Small scale systems cover an irrigated area of less than 200 hectare, growing primarily subsistence crops. Irrigation systems between 200 and 3,000 hectares are medium and large irrigation systems cover an area of 3000 hectares or more (WSDP, 2002). Small-scale irrigation is widespread and has a vital role to play in Ethiopia. The success of small scale systems is due to the fact that they are self managed and dedicated to the felt needs of local communities. In deed, small-scale schemes are defined as schemes that are controlled and managed by users themselves (Taffa, 2002).

According to Taffa (2002) the main advantages of small-scale irrigation schemes are:

- Much lower investment costs, and in a majority of cases these costs are borne by the community
- Do not involve dams or storage reservoirs, hence no population displacement is Involved
- Less demanding in terms of management, operation and maintenance

- No land tenure or resettlement implications
- No serious adverse environmental impact
- Allow a wider diffusion of irrigation benefits and permit farmers to learn irrigation techniques at their own pace and in their own way.

2.2.3.1. Status and potential of small scale irrigation in Ethiopia

The estimates of the irrigation potential of Ethiopia vary from one source to the other, due to lack of standard or agreed criteria for estimating irrigation potential in the country (IWMI, 2005). According to MoWR (1999) the irrigation potential of the country is one of the most underutilized opportunities. The country has an irrigable land of about 3.7 million hectare whereas the total irrigated area is 190,000 hectare. The size of area cultivated under small scale irrigation system is about 70,000 hectare (WSDP, 2002). In addition to the government, several organizations are involved in the planning, designing and construction of small scale irrigation schemes (IWMI, 2005).

2.2.3.2. Small scale irrigation management

According to Byrnes (1992) irrigation management activities include three dimensions. These are (1) water use activities (2) control structure activities and (3) organizational activities Water use activities: management activities focusing on the provision of water to crops in an adequate and timely manner includes acquisition, allocation, distribution and drainage. Acquisition is the first management activity concerning the acquisition of water from surface or subsurface sources, either by creating and operating physical structure such as dams' weirs or wells or by actions to obtain some share of an existing supply. Allocation refers to the assignment of rights to users thereby determining who shall have access to water.

Distribution refers to the physical process of taking the water from a source and dividing it among users at certain places, in certain amounts, and at certain times. Drainage is important where excess water must be removed (Byrnes, 1992). Control structure activities: management activities focusing on the structures required for water control include design, construction, operation and maintenance. Design involves the design of dams' diversions or well to acquire water, of systems of rules to allocate it, of channels and gates to distribute it and of drains to remove it. Construction involves the construction of the structures to acquire, distribute and remove water, or implementation of rules that allocate it.

Operation refers to the operation of the structures that acquire, allocate, distribute or remove water according to some determined plan of allocation. Maintenances is the final control structure activity. This provides for the continued and efficient acquisition, allocation, distribution and drainage.

Organizational activities: management activities focusing on the organization of efforts to manage the structures that control irrigation water include resource mobilization conflict resolution communication and decision-making. The activity of resource mobilization entails marshalling management and utilization of funds manpower, materials, information or other inputs needed to control water through structures or to undertake various organizational tasks.

The activity of communication entails conveying information about decisions made, resource requirements etc. to farmer or any other persons involved in irrigation managements. The activity of decision making entails the processes including planning involved in making decision about the design, construction, operation or maintenance of structures; acquisition, allocation, distribution or drainage of water or the organization deals with these activities.

It was assumed that devolving management responsibility with or without some form of scheme ownership to the irrigating farmers, improves scheme performance water distribution and productivity, while saving public resources for agencies to carry out such tasks (IWMI, 2005).

Merrey et al. (2002) also indicate that irrigation management transfer helps reduce the government's recurrent expenditures for irrigation. Irrigation systems in many developing countries were established with substantial financial contribution from international donors. It was assumed that the government and or water users would be able to incur the cost of operation and maintenance (O & M) of the systems made possible by enhanced financial gains from improvement in productivity levels of irrigated agriculture.

2.2.3.3. Environmental impact of small scale irrigation schemes

Irrigation development may have both positive and negative impacts on the environment (FAO, 1997). To a large extent environmental and health issues associated with irrigation and water development in Ethiopia are not to be linked to the limited knowledge of the issue, lack of capacity and resource to

invest and mitigate the constraints and limited knowledge of indigenous practices used to protect human health or the environment (Manoncourt and Murray, 1996).

Negative environmental impacts of irrigation development occur off-site as well as on site. The effects take place upstream of the land to be developed, where a river is to be dammed for the purpose of supplying irrigation. Another set of problem is generated down stream from the irrigated area by the disposal of excess water that may contain harmful concentration of salts, organic waste, pathogenic organisms, agrochemical residues, and causing siltation, water logging and erosion. Sometimes full utilization of the water creates water shortage to down stream affecting the ecosystem negatively (Wagnew, 2004).

According to the same study, malaria and schistosomiasis have historically been present in Tigray, but only seasonally during the rainy months. The presence of micro dams has increased the prevalence of these ailments during the other seasons, as standing water provides a favorable environment for disease transmission (MUC, 1994).

To be sustainable, irrigation must avoid the negative impacts (FAO, 1997). Carefully designed irrigation dams could significantly improve agricultural production and food security. Construction of small scale irrigation schemes with proper management results in improved livelihood with positive impacts on microclimatic and environmental conditions (Mintesinot et al., 2002).

2.2.4. Water harvesting for food security in Ethiopia

The history of water harvesting in Ethiopia dated back as early as the pre Axumit period (560 BC). It was a time when rain water was harvested and stored in ponds for agricultural and water supply purposes (Getachew, 1999). Rain water harvesting is when the precipitation is collected from a small or large surface area (catchments) and directed through channels to a storage facility or to a nearby field or retained at the site itself. The rainwater harvesting most commonly practiced in Ethiopia today are run-off irrigation (run-off farming), flood spreading (spate irrigation), in-situ water harvesting (ridges, micro basins, etc) and roof water harvesting (Getachew, 1999).

In Ethiopia the intensity and duration of rainfall is highly erratic and variable, resulting in significant reduction in agricultural production and in some cases total crop failure. To avert or reduce the threat of complete crop failure and promote food security, effective planning and development of water resource becomes critically important. To curb the food insecurity problem of the people and also satisfy the policy of the government (Agricultural Development Led Industrialization), attempts are being made to increase the productivity of the agricultural sector of the economy. This can be achieved through tackling the major factors affecting its productivity, namely shortage of water (Mintesinot and Kifle, 2002).

2.3. Empirical Evidence: impact of Irrigation on Household Food Security

Most empirical studies on the subject confirm that reliable and adequate irrigation increases employment. Landless laborers as well as small and marginal farmers have more work on more days of the year. A study conducted in 10 Indian villages in different agro-climatic regions shows that increasing irrigation by 40 percent was equally effective in reducing poverty as providing a pair of bullocks, increasing educational level and increasing wage rates..

A study by Hussain et al. (2004) confirms that, access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities; both on farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas. Hussain et al. (2004) identified five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare.

According to a study carried out on five irrigation schemes in Zimbabwe, the schemes were found to act as sources of food security for the participants and the surrounding community through increased productivity, stable production and incomes. The farmers participating in the irrigation schemes never run out of food unlike their counterparts that depend on rain-fed agriculture (Mudima, 1998)..

Ngigi (2002) disclosed that for the two decades in Kenya agricultural production has not been able to keep pace with the increasing population. To address this challenge the biggest potential for increasing

agricultural production lies in the development of irrigation. According to the same study, irrigation can assist in agricultural diversification, enhance food self sufficiency, increase rural incomes, generate foreign exchange and provide employment opportunity when and where water is a constraint. The major contributions of irrigation to the National economy are food security, employment creation, and foreign exchange.

In Ethiopia a study conducted by Woldeab (2003) identified that in Tigray irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming.

2.3.1. World Food Security Situation

FAO estimates that 852 million people worldwide were undernourished in 2000-2002. This figure includes 815 million in developing countries, 28 million in the countries in transition and 9 million in the industrialized countries. The number of under nourished people in developing countries decreased by only 9 million during the decade following the world food summit base-line period of 1990-1992. During the second half of the decade, the number of chronically hungry in developing countries increased at a rate of almost 4 million per year, wiping out two third of the reduction of 27 million achieved during the previous five years (FAO, 2004). World wide, per capital food availability is projected to increase around 7 percent between 1993 and 2020, from about 2,700 calories per person per day in 1993 to about 2,900 calories. Increases in average per capital food availability are expected in all major regions. China and East Asia are projected to experience the largest increase and west Asia and North Africa the smallest. The projected average availability of about 2300 calories per person per day in Sub Saharan Africa is just barely above the minimum required for healthy and productive life.

Since available food is not equally distributed to all, a large proportion of the region’s population is likely to have access to less food than needed (Andersen, 2001).

In Sub-Sahara Africa, slow growth of the agricultural sector has led to the poor performance of cash crops, which are the main sources of exports to finance food imports. Sub-Saharan Africa's share of global agricultural exports declined form 13 percent in 1970 to about 2 percent in 2000. If the region had

maintained its global market share, the value of its agricultural export would have been $44 billion higher in 2000. In other words, the region's agricultural exports would have been five times their actual level if Sub-Saharan Africa's share of global exports had remained at 13 percent, thus increasing the regions food import capacity and perhaps improving food security Shapouri and Rosen, 2003).

2.3.2. Food Security Situation in Ethiopia

Ethiopian history is punctuated by famine. Although most of the occurrences fall with in the past 200 years, food related crises can be traced as far back as 250 BC. Several incidences of famines were reported since then. The most recent tragic famines were experienced in 1984/85 (Webb and Braun, 1994).

Currently nearly about 14 million people are food insecure in Ethiopia. Therefore, there is a pressing and urgent needs to assist farmers to be able achieve food security through rapid increase in food productivity and production on an economically and environmentally sustainable basis (Gezahegn et al., 2004).

Because of the primary dependence on crop production in Ethiopia, harvest failure leads to household food deficits which in the absence of off farm income opportunities and/or timely food aid assistance, leads to asset depletion and increasing level of destitution at the household level. The effect is mirrored at the national level, resulting in overall declining food availability and increased reliance on food aid import to prevent wide spread mortality. Over the last fifteen years this situation has resulted in Ethiopia importing average of 700,000 metric ton food aid per annum to meet food needs among others, demonstrating the scale of the problem in Ethiopia (MoFED, 2002).

A report from DPPC (2004) discloses that the people in need of relief food assistance are highly vulnerable crop-dependent farmers or livestock-dependent pastoralists and agropastoralists affected by acute shocks such as adverse weather conditions, below normal or erratic rainfall and extended dry spells during critical periods of the cropping cycle. The lingering effect of the multiple shocks they have sustained in recent years, leading to a gradual depletion of their household asset-base and limited income options have further exacerbated the food situation of these acutely affected populations (Table 2.1).

Table 2.1: **Emergency beneficiaries for the Year 2008 to 2013**

S/N	Year	Woreda level No. of emergency beneficiaries
1	2008	6924
2	2009	6448
3	2010	6460
4	2011	4300
5	2012	3919
6	2013	2696

To achieve food security and reduce poverty, the logical and paramount goal of the government of Ethiopia is to pursue objectives of sustainable development. Sustainable development entails the harmonization of population growth with utilization and exploitation of the natural resource. This requires redirection and reorientation of research and development as well as institutional change. The basic requirement in this harmonization process is to address change posed by negative synergy arising from rapid population growth, environmental degradation and low agricultural production, leading to food insecurity (Gezahegn et al., 2004).

Thus, there is an urgent need to harness soil and climate resources in an agro ecological balance sense for sustained and increased crop production in the country. Effective technologies are needed to sustain dry land agriculture. The primary socioeconomic concern which should be taken into account is that rain fed agriculture particularly in the dry land is very complex and a high – risk enterprise. Thus, a system approach and risk management is key issue.

Chapter three: Research Methodology

3.1. Study area- profile

Laelay -Maichew Woreda is located in central zone of the Tigray regional state bordered with Tahtay – Maichew Woreda in the west, Naedier-Adiet in the south, Rural Adwa in the East and Mereb-Lekhe woreda in the east. The main means of livelihood of the people in woreda is mixed farming through subsistence agriculture.

The altitude of the area ranges from 1840 - 2600 masl and the mean annual rainfall is 600 to 650 mm. Most part of the cultivated land is situated on the middle and lower altitude. The most common types of crops in the watershed area include: teff, wheat, barley, finger millet, sorghum, maize and faba bean. Farmers plant finger millet, sorghum and maize when the Azmera rainfall is favourable. If the *azmera* rains are absent they plant short season crops like barley, wheat and Teff. The average crop production is 28 quintal per hectare.

In general; the feed resource is not compatible with the number of livestock in the watershed. There is very high deficit of forage both in wet and dry seasons

The woreda has a total land size of 53, 833 ha. Out of the total area of the woreda 14,552 ha of land is used for crop production, of which 5,595 ha is potential land for irrigation, 13,761 ha covered by forest, 4,405.5 ha for grazing land, and 1231.75 ha for homestead and 8.397.5 ha is miscellaneous land. The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction. The agricultural production is mostly based on rain-fed agriculture with some traditional irrigation. Average farm size is 0.50 ha. Sowing is mostly practiced with broadcasting method and harvesting is done with sickle mowing and threshing by oxen trampling.

The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction.

The woreda has a total population of 15.785 in 18 kebeles. The average HH size is 4.5.

The woreda has a total farm land of 14, 572 ha of which 5,595 ha can be used for irrigation farming. In 2003, around 5,350 ha of land were under irrigation from different water sources. There are three small scale irrigation dams in the woreda namely Mai Nugus, May Seie, and May Gundi and one diversion with a total potential of irrigating 266 ha where 1064 farmers can be beneficiaries. On average the irrigable land size of a household is 0.20 to 0.25 ha .Farmers in the woreda also practice irrigation from water ponds, diversion, motor pups, etc. according to the woreda office of agriculture there are 13, 900 farmers practicing irrigation. Dura kebele is one of the kebele where the Mai Nugus irrigation scheme is found. Prior to the project, the community had been under serious food stress and survived mainly by external food aid. In spite of the fatal food insecurity problems in the area, the area has endowed with huge potential of irrigable fertile land in the Dura kebele.

The study focuses on assessing the impact of an Irrigation scheme on the improvement of sustainable food security. This study is limited to only one district because of the limited time and resource. The woreda where the study will be conducted is Laelay Maichew. It is found in the central zone of Tigray Region. This district is selected because of the researcher's attachment to the project areas and the relatively better irrigation practices with the use of earth dam as communal small scale irrigation scheme.

3.1.1. Location

Laelay -Maichew Woreda is located between 8 22-8 56'N latitudes and 38 58-39 22' E longitudes.in central zone of the Tigray regional state bordered with Tahtay –Maichew Woreda in the west, Naedier-Adiet in the south, Rural Adwa in the East and Mereb-Lekhe woreda in the east. It also enclaves the town of Axum and has an estimated area of 33.77 km2. There are 45 peasant associations in the district (DESFED, 2004).

3.1.2. Climate

The altitude of the area ranges from 1840 - 2600 masl and the mean annual rainfall is 600 to 650 mm. Most part of the cultivated land is situated on the middle and lower altitude. It has Woinadega 2 agro-climate.

3.1.3. Population

Currently, the district has a total population of 84,223 out of which 41,984 (49.85 percent) are male and 42,238 (50.15 percent) are female. In terms of age category 44 percent of the population is under the age of 15 and 4.43 perc**ent** of the population are above the age of 64, while 51.88 percent of the population is categorized to the age group of 15-64, (CSA, 2007 and Data extrapolated).

3.1.4. Agriculture

Agriculture is the main stay of the district and hence it provides the largest share of the livelihood for the population. However, it is characterized by lack of access to modern technology, market, low productivity, dependency on rainfall and lack of irrigation practice. As a result, the sector remains subsistence in its nature (DESFED, 2004). The main means of livelihood of the people in woreda is mixed farming through subsistence agriculture.

The most common types of crops in the watershed area include: teff, wheat, barley, finger millet, sorghum, maize and faba bean. Farmers plant finger millet, sorghum and maize when the Azmera rainfall is favourable. If the *azmera* rains are absent they plant short season crops like barley, wheat and Teff. The average crop production is 28 quintal per hectare.

In general, the feed resource is not compatible with the number of livestock in the watershed. There is very high deficit of forage both in wet and dry seasons. The woreda has a total land size of 53, 833 ha. Out of the total area of the woreda 14,552 ha of land is used for crop production, of which 5,595 ha is potential land for irrigation, 13,761 ha covered by forest, 4,405.5 ha for grazing land, and 1231.75 ha for homestead and 8.397.5 ha is miscellaneous land. The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction. The agricultural production is mostly based on rain-fed agriculture with some traditional irrigation. Average farm size is 0.50 ha. Sowing is mostly practiced with broadcasting method and harvesting is done with sickle mowing and threshing by oxen trampling.

The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction.

3.1.5 Description of the irrigation scheme

This study is limited to only one district because of the limited time and resource. The woreda where the study will be conducted is Laelay Maichew. It is found in the central zone of Tigray Region. This district is selected because of the researcher's attachment to the project areas and the relatively better irrigation practices with the use of earth dam as communal small scale irrigation scheme.

Mai Nigus irrigation scheme has the capacity to develop 310 ha of land. The irrigable land in the command area was distributed to farmers by the government. Except few farmers who lease in additional irrigable land almost all farmers in the area own quarter of a hectare (one Tsimad 5). 5 One Tsimad means quarter of a hectare in the local language 'Tigringa'.

This study is conducted on one small scale irrigation scheme that is found in Laelay Maichew district of Tigray regional state. May Nigus is the small scale irrigation scheme. The irrigation scheme was constructed by Commission Sustainable Agriculture and Environmental Rehablilitation in Tigray(CO-SEART) in 1998.

3.2. Research Methodology

In this section, sampling method, data collection and analysis method at which the study is going to use in this research investigation process would be explained.

3.2.1. Sampling procedure – size of sample to be used

According to the woreda office of Agriculture and Rural Development, the project is benefiting three villages drawn from three kebeles in the district. All the three villages in the three kebeles was considered in the study. A total of 874 HHs, of which 743 HHs (85%) are beneficiaries of the irrigation scheme. Thus, beneficiaries and non beneficiary HHs was randomly selected from the three villages in the three kebeles. Proportional sampling have been adopted. Hence, the number of project beneficiaries

sampled for the study is higher from Dura kebele and implyiing that higher number of respondents was selected from this kebele.

Random sampling procedure was used to select sample households. The first step in determining statistically acceptable sample sizes involved selecting a variable on which to base the sample size calculations and apply the sample size determination formula. Hence, for the study, access to irrigation among the households in project area was used as key outcome variable with a binomial distribution, i.e. a household can have access to irrigation or not. Based on the reports of from woreda office of agriculture and rural development, the coverage in terms of access to irrigation in the study area in 2011/12 (2003 E.C.) was 85%. Thus, the proportion of the targeted population, measured by the household units, who have no access to irrigation, is 15%. In order to determine a statistically acceptable sample size, the following scientific formula which is normally applied for variables with binomial distribution was used (Kothari, 1995 and Fisher et al, 1991).

$$n = k\frac{z^2 p(1-p)}{d^2}$$

Where:

n = statistically acceptable minimum sample size.

z = standard normal deviation. The value corresponding to the required degree of accuracy (d) is shown on table 1 below

p = proportion of the targeted population, or households, estimated to have no access to irrigation.

d = degree of accuracy desired, usually set at 0.05.

k = design factor providing a correction for the loss of sampling efficiency resulting from the use of cluster sampling instead of simple random sampling. Every time a stratum is added to a sampling system, the design factor should be doubled. Thus, since it is a two stage cluster sample (village and household) sample, k should be 2.

Table 3.1: Z Values Corresponding to d Values

D	*Z*
0.1	*1.282*
0.05	*1.645*
0.025	*1.96*
0.0125	*2.326*

Thus, based on the above premise and using those parameters, the computed sample size or n was 276 households (from both beneficaries and non beneficaries). The sample households was distributed to each of the three villages in proportion to the size of households (for both beneficaries and non beneficaries) in the three villages.

3. 2.2. Methods of data collection

To minimize the problem of lack and reliability of information, different methods (triangulation) of data collection was employed. More importantly, semi-structured questionnaire was designed and implemented to collect HH information on food production, stock/asset building, farm land size, irrigation water use, supply of improved agricultural inputs and agricultural extension services. Besiedes, two focus group discussions, one at community level and the other at woreda level were organized. At community level, 8 HH heads were participated both from beneficiary and non beneficiaries. At woreda level, 6 experts represented from different woreda government and project offices have participated. Key informants were aslos selected from the community (10 people), project staff (3 people) and woreda government staff (3 people) for in-depth interview on before and after project food security situation, project results and sustainability. One focus group discussions from beneficiary and non beneficiaries was organized for in-depth interview on food security situation, project results and sustainability

Secondary data on quantity of food production and rainfall (time series) and agricultural inputs supply was also collected from different concerned sectors and food security literatures.

The secondary data were collected from Bureau of Agriculture and Natural Resources, Bureau Water Resources, and other related research documents and literatures.

3.2.3. Methods of Data Analysis

The collected data through Household survey was coded and entered in to a computer for statistical analysis using computer software SPSS version 13 software to asses the impact of the irrigation scheme on the household's food security. The research study was mainly focused on community and HHs as units of analysis and both quantitative and qualitative approaches were broadly used in the analysis of data. Data obtained from secondary sources like rainfall, construction related and those data generated from HHs' survey were quantitatively analyzed using simple statistical tools such as tables and charts.

Chapter four: Survey Result and Discussions

In the study area small scale irrigation management activities include water use activities such as acquisition, allocation, and distribution, control structure activities which refer to design, construction and operation and maintenance and organizational activity which includes activities like resource mobilization, conflict resolution and decision making. Water use activities: the study identified that each scheme has a water users association (WUA). The WUA is responsible for coordinating the water distribution. The WUA has nominated an individual who is responsible to open gate as per the program of each of the villages. The study also tried to identify if there is any relationship between water distribution and household size, location of the household to the schemes, sex of the household head and financial status of household. The survey showed that location plays a significant role with regard to water distribution that is, those farmers that are located in the upper part of the scheme benefit more. Female headed household have equal opportunity to use water as men provided that they are heading a family. However, they do not participate in the WUA committee.

Regarding administrative problems related to water distribution the study disclosed that absence of sanction and poor coordination of water users association are the main administrative problems in relation with water distribution. Some of the illegal water use activities in the area include: letting cattle drink the irrigation water, diverting the water course to ones farm land etc. Control Structure Activities: the design and construction of the May Nigus scheme was undertaken by Commisssion for Sustainable Agriculture and Environmental Rehabiliation in Tigray, CO-SAERT with the participation of the users (beneficiaries). The community participated in the construction of the schemes through provision of labor for excavation of canals and head work, supply of locally available construction materials such as stone and sand. The survey disclosed that there is maintenance of the schemes two times a year. Maintenance here refers to cleaning of canals when filled with grass and mud.

The survey also revealed that almost all the farmers are willing to pay for operation and maintenance of the schemes, 95 percent of the respondents confirmed their willingness. The farmers' willingness may arise from the sense of belongingness. Almost all the farmers 100 percent) responded that the scheme belongs to them. In Ethiopia farmers do not pay for irrigation water use, according to OIDA (2000) this

is not because of the failure to recognize the economic value and the real cost of service provision, rather the government wants to subsidies the cost of developing small scale irrigation projects.

Organizational Activities: resource mobilization as stated previously is poorly undertaken since irrigation users do not pay for the service they are being offered. This implies that in the study area there are no activities like fund raising and utilization. Manpower and information management and utilization is under taken through water users association, although the only activity is cleaning of the canals using hand tools like shovel.

4.1. Dempographic Characterstics of the survey household

4. 1.1. Household size

According to the study (Table 4.1), the average household size of the total sample households in adult equivalent was 5.81 persons, with 1 and 9 being the minimum and the maximum household sizes respectively. When we compare the average household sizes between irrigation users and non users, the study revealed that households that use irrigation have smaller household size than households that do not use irrigation. Average household size for users is 6.07 persons and 5.1 persons for non users. In line with this, the average household size for the country is 4.8, (4.9 in rural areas and 4.3 in urban), PASDEP-2002.

4.1.2. Marital Status of head of HH

Of the interviewed 236 household heads 78.4 percent are married with single wife. Similarly 11.9 percent are widowed and 9.7 percent are divorced ones (Table 4.1).

4.1.3. Religion of head of HH

With regard to religion most of the respondents are orthodox. That is 96.6 percent and 3 percent is orthodox and Muslim respectively (Table 4.1).

4.1.4. Age of the household head

The average age of the sample household head is 48.32 years where the minimum is 32 and the maximum is 75. The average household age of irrigation users is 48.47 and the corresponding figure for non users 47.58 (Table 4.1).

Table 4.1 Demographic status of households

Descripition	No HHs	Percent
Family size		
1 – 2	3	1.3
3 – 4	44	18.6
5 – 7	156	66.1
Above 7	33	14.0
Total	236	**100.0**
Married/ single wife/	185	78.4
Divorced/ Separated	23	9.7
Widowed	28	11.9
Total	236	100
Orthodox	**228**	96.6
Catholic	1	0.4
Muslim	7	3
Total	**236**	**100**

Source: survey result

4.1.5. Sex of the household head

According to the survey result, 20.76 percent of the sample households are headed by females and the rest 79.23 percent are headed by male. When we see the comparison by access to irrigation, out of the 195 irrigation user households 183 /93.84 % / are male headed and 12 /6.15%/ are female headed and the corresponding figure for non users is 24 /58.54 %/ is male headed and 17 / 41.46 %/ is female headed (Table 4.2).

Table 4.2: Sex of the household head

Sex	Response by users and non-users			
	Irrigation users		Non-users	
	Number	Percent	Number	Percent
Male	163	87.17	24	12.83
Female	32	65.30	17	34.70
Total	**195**	**82.60**	**41**	**17.40**

According to PASDEP (2002), of the estimated 13.4 million households, about 75% are maleheaded and 25% female-headed. It is estimated that about 16% of households are urban dwellers and 84% rural.

A much higher proportion of female-headed households reside in urban areas compared to rural areas. About one-out-of five rural households (22%) and nearly two out of five urban households (39%) are female-headed households.

4. 1.6. Level of education of the household head

In the study area (Table 4.3), 33.5 percent of the sample household heads are found to be illiterate, where as 33.9 percent of the sample household heads read /write, 21.2 percent have attained education level grade 1-4, 8.9 percent have attained education level grade 5-8 and 2.5 percent greater than grade 8. The comparison by access to irrigation reveals that 29.74 percent users and 51.22 percent non users are found to be illiterate. 2.05 percent user household heads have attained grade greater than 8 the corresponding number for non user household heads is 4.88.

Table 4.3: Education level of Head of HH

Response by surveyed HHs	Education level					Total
	Illiterate	Read/ write	Elementary, Grade 1-4	Junior Secondary Grade 5-8	High School, Above 8 grade	
Users	58 (29.74%)	72 (36.92%)	43(22.05%)	18 (9.23%)	4 (2.05%)	195
Non-users	21 (51.22%)	8 (19.51%)	7(17.32%)	3 (7.32%)	2 (4.88%)	41
Total	**79(33.47%)**	**80 (33.90%)**	**50 (21.19%)**	**21(8.90%)**	**6 (2.54%)**	**236**

Source: survey result

Accroding to PASDEP**,** at all levels, irrespective of gender, the proportion of literate population is increasing over the survey years. In rural areas, the literacy rate increased from 18% in 1995/96 to 31% in 2004/05. Though narrowing over time, gaps in literacy rate between rural and urban areas and males and females is still significant. Literacy rate at national level has increased from 26% 28 in 1996 to 38% in 2004. Male literacy rate increased from 35% in 1996 to 50% in 2004 while female literacy rate increased from 17% in 1996 to 27% in 2004.

The study also revealed that 87.9 percent of the irrigation users and 12.03 percent of non users send their children to school. In essence, 25 percent of the users and 75 percent of the non users do not send their children to school. Overall 91.53 percnt of the respondants send children to school while 8.47 percent not. The main reason for not sending children to school is need children to work in house or on the farm due to shortage of labour.

Table 4.4: HHs who sends children to school

HHs Send children to school	Response by users and non-users				Total HHs	
	Irrigation user		Non-user			
	Number	Percent	Number	Percent	Number	Percent
Yes	190	87.9	26	12.03	216	91.53
No	5	25	15	75	20	8.47

Source: Survery result

Table 4.5: Reason for not sending children to School

S/No	Reason for not sending children to School	No HHs	Percent
1	I need my children to work in house or on the farm (shortage of labour)	7	2.96
2	Health problem	4	1.7
3	Other	6	2.54
4	Not Applicable	219	92.8
	Total	**236**	**100**

Source: survey result

4.1.7. Occupation of head of HH

In this regard, Table 4.6 below revealed that 90.3 percent of the respondents are occupationally farmers who made a living by cultivating own farmland. On the other hand, additional 3.4 percent of the surveyed households are farmers who made a living either by cultivating own or family land and engaging in other paid work (handcraft, trader, wage worker, artisan, etc).

Table 4.6: Occupation of head of HH

S/No	Type of Occupation	No head of HHs	Percent
1	Farmer(cultivates own or family land)	213	90.30
2	unpaid domestic work(incl. house wife)	1	0.40
3	Herding	2	0.80
4	Other paid work(handcraft, trader, wage worker, artisan, etc)	3	1.30
5	Trader (own Business	2	0.80
6	Weaver	2	0.80
7	other-	1	0.40
8	Farmer(cultivates own or family land) and Other paid work(handcraft, trader, wage worker, artisan, etc)	8	3.40
9	Farmer(cultivates own or family land) and Trader (own Business)	3	1.30
10	Farmer(cultivates own or family land) and weaver,(	1	0.40
	Total	**236**	**100**

Source: survery result

4.2. Agriculture, Input and Production

4. 2.1. Farm land ownership and Size of cultivated land

The survey result (table 4.7) showed that 97.46 percent of the surveyed households have farm land while 2.54 percent do not have their own farm land to cultivate crop for their own household. Though the entire users have farm land, 14.5 percent of non users do not have land.

Table 4.7: Farm land Ownership

Resposnse by surveyed HHs	Farm Land Owership			
	Yes		No	
	Number	Percent	Number	Percent
Users	195	100.00	0	0.00
Non-users	35	85.37	6	14.63
Total	**230**	**97.46**	**6**	**2.54**

Source: survey result

Table 4.8 below depicts that 42.4 percent of the irrigation users owned 0.5 ha of irrigable land and 40 percent have less than 0.25 ha and 23.73 percent have greater than 0.5 ha of irrigable land.

Table 4.8: Total Irrigable farm land Owned by HHs

S/No	Farm land Size (ha)	Frequency	Percent
1	Less than 0.50	80	33.9
2	Equal 0.5	100	42.37
3	Greater than 0.5	56	23.73
Total		**236**	**100**

Source: survery result

With regard to access to natural resources, the study revealed that 44.5 percent of the irrigation user households have access to use of natural resources. That is 43.6 percent of users and nearly 49 percent of non uses have access to natural resources.

Table 4.9: Access to Natural Resource

Irrigation User	Access to Natural Resource			
	Yes		No	
	Number	Percent	Number	Percent
Ye	85	43.59	110	56.41
No	20	48.78	21	51.22
Total	**105**	**44.49**	**131**	**55.51**

Source: survey result

As to ownership of farm land, the study as depicted in table 4.10 revealed that 96.6 percent of the households get the farm land through land distribution by the government and 3 percent from family. Moreover, the study showed that 2.5 percent of the respondents indicated that land distribution is done for households whose farm land is located in the irrigation facilities only. On the other hand, the study showed that 34.7 percent of the respondents reported that lack of land distribution have affected farm investment considerably.

Table 4.10: Farm land Distribution

Descripition	No HHs	Percent
How did household get the farm land?		
Through land distribution	228	96.6
From Family	7	3
NA	1	0.4
Total	**236**	**100**
Is there farm land distribution?		
Yes, in Irrigated land	6	2.5
No	230	97.5
Total	**236**	**100**
Does lack of Land Distribution Affect Investiment?		
Yes	82	34.7
No	154	65.3
Total	**236**	**100**

Source: survey result

4. 2.2 Livestock holding

Oxen are the main sources of draft power for cultivation in the study area (LoARD, 2012). Table 4.11 below indicated that out of the 236 sample households, 187 /79.23 percent / of the respondents have one or more ox while 49 /20.76 percent / of the households do not have at least one ox. Compareing the irrigation user and non user households, 84.6 percent of the irrigation users and 53.7 percent of non users have one and more oxen. Thus, more of irrigation usres have better ox holding than non user households. On the other hand, 15.4 percent of the users and 46.3 percent of non users do not have ox at all.

With regard to cow ownership, the study showed that out of the 236 sampled households, 158 /70%/ of the respondents have one or more cow while 78 /33%/ of the households do not have cow. Compareing the irrigation user and non user households, nearly 75 percent of the irrigation users and 29 percent of non users have one and more cow. Thus, more of irrigation usres have better cow holding than non user households. On the other hand, 25.13 percent of the users and 70.7 percent of non users do not have cow at all.

Table 4.11: Number of cattle possession by Houesholds

Irrigation User	Number of cattle possession by Houesholds							
	0		1		2		3	
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
	Number of Ox Owned							
Yes	30	15.38	32	16.41	111	56.92	11.28	11.28
No	19	46.34	12	29.27	10	24.39	0	0
Total	**49**	**20.76**	**44**	**18.64**	**121**	**51.27**	**22**	**9.32**
	Number of Cow Owned							
Yes	49	25.13	132	67.69	14	7.18		
No	29	70.73	10	24.39	2	4.88		
Total	**78**	**33.05**	**142**	**60.17**	**16**	**6.78**		
	Number of Calf Owned							
Yes	71	36.41	124	63.59				
No	37	90.24	4	9.76				
Total	**108**	**45.76**	**128**	**54.24**				

Source: survery result

Similarily, with regard to shoat ownership, the study found that 147 (62) of the respondents have one or more shoat while 89 (38%) of the households do not have shoat. Compareing the irrigation user and non user households, 64 percent of the irrigation users and 54 percent of non users have one and more shoat. Thus, the study revealed that irrigation users have better shoat holding. On the other hand 35.9 percent of the usrs and 46.34 percent of non users do not have shoat at all.

With regard to pack animals ownership, the study showed that out of the 236 sample households 129 /54.7 percent / of the respondents have one or more pack animal while 107 /45.34 percent / of the households do not have pack animal. Compareing the irrigation user and non user households, 60 percent of the irrigation users and 29.27 percent of non users have one and more pack animal. Thus more of irrigation usres have pack animal holding than non user households. On the other hand, 40 percent of the usrs and 71 percent of non users do not have pack animal at all.

On the other hand, the study indicated that bee ownership is very low in the study area with only 12.7 percent of the respondents reported to have one or more bee while 87 percent of the households do not have bee. Compareing the irrigation user and non user households, 14.4 percent of the irrigation users and 5percent of non users have one and more bee. Thus, more of irrigation usres have bee holding than non user households. On the other hand, 85.64 percent of the usrs and 95.12 percent of non users do not have bee at all.

With regard chicken holding, the study found that chicken holding is almost common in both users and non users in the study area. In line with this, 80 percent of the respondents have one or more checken while 20 percent of the households do not have chicken. Compareing the irrigation user and non user households, 86 percent of the irrigation users and 54 percent of non users have one and more chicken. Thus, more of irrigation usres have chicken holding than non user households. On the other hand 14.4 percent of the users and 46.3 percent of non users do not have chicken at all.

4. 2.3. Total crop production

The major crops grown in the study area are teff, wheat, barley, finger millet, sorghum, maize and faba bean. Farmers plant finger millet, sorghum and maize when the Azmera rainfall is favourable. If the *azmera* rains are absent they plant short season crops like barley, wheat and Teff. The study revealed that the average crop production under rainfed is 22.6 quintal per hectare. The average crop production per hectare varies from 16.75 qt in 2001/02 E.c to 26.88 qt in 2003/04 E.c production year.

Table 4.12: Crop production under rainfed

Produ ction Year/ E.C/	**Qty**	**Area(ha)**
2000/01	271,529	14,714
2001/02	246,492	14,714
2002/03	363,324	14,714
2003/04	395,480	14,714
2004/05	375,753	14,233
Total	**1,652,578**	**73,089**
Mean	**33,0515.6**	**14,617.8**

The data collected from the woreda office of agriculture indicated that the average irrigation vegetable production per hectare was 173.1 qt, 191.6 qt and 204.3 qt in 2003/04, 2004/05 and 2005/06 production year, respectively.

Table 4.13: Crop production under Irrigation

Production Year/ E.C/	Yield in quintal			Area(ha)		
	Vegetable	Cereals /beans/	Spices	Vegetable	Cereals /beans/	Spices
2003/04	521,100.0	9,064.0	3,236.0	3,010.3	2,150.0	325.0
2004/05	552,208.0	61,404.0	1,557.0	2,882.0	2,491.0	220.0
2005/06	658,085.8		1,333.2	3,220.5	3,492.0	225.0
Total	**1,731,393.8**	**70,468.0**	**6,126.2**	**9,112.8**	**8,133.0**	**770.0**
Mean	**190.0**	**8.7**	**8.0**			

Table 4.14: Use of seed and pesticide under Irrigation

Produ ction Year/ E.C/	**Seed/Qt**	**Pesticide/qt**
2003/04	152.0	2,695.00
2004/05	223.0	2,705.00
Total	**375.0**	**5,400.00**
Mean	**187.5**	**2700.00**

Source: Survey result

4.2.3.1. Rain fed Agriculture

The study found that (Table 4.15) 84, 18, 70 and 83 percent of the respondents use chemical fertilizer, improved seed, manure (organic fertilizer) and pesticeds under the rainfed agriculture, respectively. Comparison of agricultural input use among irrigation users and non-users indicated that 89, 75, 18, and 88 percent of irrigation users use chemical fertilizer, imporved seed, organic fertilizer (manure) and pesticides respectively indicating higher percentage of use by irrigation users.

Table 4.15: Use of agricultureal input under rainfed agriculture

Description	Irrigation User	Response on use of Agricultural Input	
		Yes	**No**
Do you use chemical fertilizers?	Yes	174 (89.2%)	21 (10.8%)
	No	25 (61%)	16 (39%)
	Total	**199 (84.3%)**	**37 (15.7%)**
Do you use improved seed?	Yes	35 (18%)	160 (82%)
	No	8 (19.5%)	33 (80.5%)
	Total	**43 (18.2%)**	**193 (81.8%)**
Do you use organic fertilizer/manure?	Yes	146 (74.9%)	49 (25.1%)
	No	20 (48.8%)	21 (51.2%)
	Total	**166 (70.3%)**	**70 (29.7%)**
Do you use pesticides?	Yes	171 (87.7%)	24 (12.3%)
	No	25 (61%)	16 (39%)
	Total	**196 (83.1%)**	**40 (16.9%)**

Source: survery result

4.2.3.2. Irrigation Agriculture

Under irrigation agriculture the study revealed that 70.34, 69.5, 0.85, 83.1 and 3.4 percent the respondents use chemical fertilizer, improved seed, organic fertilizers, pesticides and local seeds respectively (Table 4.16).

Table 4.16: Use of Agricultural Inputs under Irrigated Agriculture

Description	Irrigation User	Use of agricultural Input	
		Yes	No
Do you use chemical fertilizers?	Yes	166 (85.13%)	29 (14.87%)
	No	0(0%)	41(100%)
	Total	**166 (70.34%)**	**70(29.66%)**
Do you use improved seed?	Yes	164 (84.10%)	31 (15.90%)
	No	0(0%)	41(100%)
	Total	**164(69.49%)**	**72(30.51%)**
Do you use organic fertilizer?	Yes	2 (1.03%)	193 (98.97%)
	No	0 (0%)	41(100%)
	Total	**2 (0.85%)**	**234 (99.15%)**
Do you use pesticides?	Yes	162 (83.08%)	33 (16.92%)
	No	2 (4.88 %)	39 (95.12%)
	Total	**164(69.49%)**	**72 (30.51%)**
Do you use local seeds?	Yes	8 (4.10%	187 (95.90%
	No	0 (0%)	41 (100%)
	Total	**8 (3.39%)**	**228 (96.61%)**

4.3. Income, consumption and expenditure

4. 3.1. Total Income

Table 4.17 below depicted that most income source for the irrigation user is from riigation which accounts 50.22 percent of the total income in FY 2012. On the other hand, for the non-irrigation users' income generated from rainfed agriculture accounts the highest percentage covering nearly 65 percent the total income source of the surveyed households. The mean annual income of the user and non user is Birr 32, 208.92 and 12,133.17, respectively indicating that mean annual income of irrigation users is twice that of non-users mean annual income. This attests the findings of many scolar on the subject that participation in irrigation contributes to increased income of the households.

Table 4.17: Annual income of user and non-user households in FY 2012

Source Of Income	Income	Percent
1. Users		
Rainfed	2,350,600	37.43
Irrigation	3,153,911	50.22
Other Income	776,229	12.36
Total	**6,280,740**	**100**
Mean	**32,209**	
2. Non- Users		
Rainfed	321,800	64.69
Irrigation	0	0
Other Income	175,660	35.31
Total	**497,460**	**100**
Mean	**12,133**	

Source: survery result

4.3.2. Total consumption expenditure

According to PASDEP (2002), the income dimension of poverty is being measured by real consumption expenditure valued at 1995/96 national average prices in Ethiopian Birr. Both real per capita household consumption expenditure and real per adult household consumption expenditure are reported along with family size and the level of calories consumed. The changes in real per-capita consumption expenditure and real per adult consumption expenditure are provided in Table 2.2 below.

Per capita real household consumption expenditure is obtained by dividing real household consumption expenditure by family size. Per adult real household consumption expenditure is per capita real household consumption expenditure adjusted for age and gender of household members obtained by dividing real household expenditure by adult equivalent family size.

The average family size is 4.8 in 2004/05, which is slightly lower than that of 1995/96 and 1999/00, while adult equivalent family size is 3.9, which is almost the same as that of 1995/96 and 1999/00.

The level of real total per capita household consumption expenditure stood at 1,256 Birr (US$146) in 2004/05 with food accounting for 577 Birr and the rest 678 Birr for non-food.Compared to that of 1999/00, real total per capita household consumption expenditure increased by 19% in 2004/05, which is

mainly due to an increase in real non-food expenditure by 50%. In 2004/05, real per capita food expenditure declined by 6% compared to 1999/00 and by 5% against that of 1995/96. The decline in real food expenditure was witnessed mainly in rural areas. The level of real total per adult household consumption expenditure, which is used to calculate poverty, was 1,542 Birr. Households usually allocate their income to meet food and non –food needs of their family. The sample households were asked on the quantity and value of food consumed for one year.

Table 4.18: Annual Household Food and Non- Food Expenditure (Birr- Users)

Description	Total Expenditure	%
Food expenditure		
Ceraels	2054460	75.46
Pulse and oil seed	158045	5.80
Vegetables	8183.8	0.30
Fruit	0	0.00
Food Spices	97686	3.59
Livestock products	233014	8.56
Other foods/ drinks	31823	1.17
Other foods/flavours	139409	5.12
Total	2722620.8	**100**
Mean	13962.16	
Non - food expenditure		
Water, energy and regular	17886.21	2.7335411
Clothing	297879.3	45.524755
Health & education	265800	#DIV/0!
Social Affairs	40200	6.1437473
Others	32558.28	4.9758668
Total non- food expenditure	654323.79	**100**
Mean	15959.12	

Table 4.19: Annual Household Food and Non- Food Expenditure (Birr- Non- Users)

Description	Total Expenditure	%
Food expenditure		
Ceraels	247000	70.80
Pulse and oil seed	17322.5	4.97
Vegetables	1200.4	0.34
Fruit	0	0.00
Food Spices	20288	5.82
Livestock products	38040	10.90
Other foods/ drinks	4905	1.41
Other foods/flavours	20114	100
Total	**348869.9**	
Mean	**1789.08**	
Non - food expenditure		
Water, energy and regular	2870	3.34
Clothing	41000	47.75
Health & education	27960	32.56
Social Affairs	6900	8.04
Others	7134	8.31
Total non- food expenditure	85864	100
Mean	**2094.24**	

Source: survery result

The average monthly household expenditure on food and non food expenditure for the user sampled households were found to be Birr 13,962.16 and 15959.12 respectively. On the other hand, the average monthly household expenditure on food and non food expenditure for the non user sampled households were found to be Birr 1,789.08 and 2,094.24 respectively (Table 4.18 and 4.19).

In general, the average monthly household expenditure on food and non food expenditure were found to be higher for irrigation users indicating that access and participation in irrigation do have significant contribution on increased household expenditure on food and non-food items.

4.4. Marketing

4.4.1 Distance from market center

It is uncontested fact that access to market center is crucial in facilitating marketing of agriculture produce at fair and competitive price. In line with this, the survey revealed that the average distance to the market place in kilometer for the sample households is found to be 7.2 km with a minimum of 6 km and a maximum of 8.4 km.

4.4.2. Marketing

In this regard, the survey result indicated that 90 percent of the respondents sale their produce by taking the produce to the market and they sale their produce as individual. In the same development, 60 percent of the respondents attested that they do have marketing problem and 59.3 percent of the respondents indicated that the marketing problem is related with low price of produce. On the other hand, 15.7 percent of the respondents confirmed that the effort made by the government in creating good market access is very low or minimal indicating that institutional and organizational support in makretin of the farmers produce is non-existent.

Table 4.20: Households opinion on marketing and market access

Descripition	Number of HHs	Percent
Where do you sell your produce?		
Take to market	212	89.8
NA	24	10.2
Total	236	100.0
How do you sale your produce		
As an individual	212	89.8
NA	24	10.2
Total	236	100.0
Do you face problem in saling your produce?		
Yes	139	58.9
No	73	30.9
NA	24	10.2
Total	236	100.0
What are your marketing problems?		
Low price	140	59.3
NA	96	40.7
Total	236	100.0
Is there Government effort to addres market problem?		
Yes	37	15.7
No	178	75.4
NA	21	8.9
Total	236	100.0

Source: survey result

4.4.3. Means of transportation of agricultural produce to the market

Households in the study area use different ways of transporting their produce to the market place. Among the users, 85 percent of the households transport their produce by pack animals and 10 percent use vehicle and pack animals and 5 percent use vehicle only. Carrying on human back and using donkey are also reported as important means of transportations for few of the surveyed households. The common means of transportation for non users is pack animals maily due to limited capacity to afford the transportation cost to use vehicle.

4. 5. Access to extension service

Access to extension support is supposed to be key element for successful implementation of any irrigation scheme. In this regard, 93 % of the surveyed households reported to have access to extension support. When asked to rate the extension support they received, 98% of the respondents rated as good or satisfactory while only 2% of the surveyed households rated the extension support as poor or unsatisfactory (Table 4.21).

Table 4.21: Extension services and suppport

Descripition	Number of HHs	Percent
Did you get extension support?		
Yes	220	93.2
No	16	6.8
Total	236	100

Source: survey result

Table 4.22: HHs rating of the extension support

Response by surveyed HHS	Opinion of HH on the extension support		
	Good	satisfactory (not good or bad	bad/poor (isolated/discriminated)
Users	108(55.38%)	83(42.56%)	4(2.05%)
Non-users	22(53.66%)	19(46.34%)	0
Total	**130 (55.08%)**	**102 (43.22%)**	**4 (1.69%)**

Source: survey result

The study also revealed that 91.5 percent of the respondants actively participate and involved in any community discussions/activities/meetings. When we compare irrigation user and non user households,

majority of the user households actively participate and involved in any community discussions/activities/meetings most of the the time. According to the survey, 93.85 percent users and 80.45 percent of non users reported to actively participate and involve in any community discussions/activities/meetings with in their communities

Table 4.23: Participation and involvment in community activities

Response by surveyed HHs	Participation		
	Yes	**Sometimes**	**No**
Irrigation Users	183 (84.72%)	10 (55.56%)	2 (100%)
Non-users	33 (15.28%)	8 (44.44%)	0 (0%)
Total	**216 (91.53%)**	**18 (7.63%)**	**2 (0.85%)**

Source: survey result

With regard to training, 91.5 percent of the respondents took differet trainings related to food security, mitigation to shock, irrigation management and imporved agronomic practices. Of the 195 irrigation users, 93.33 percent of them have undergone different trainings related to irrigation and improved agriculuteal practices. Similarily, 82.93 percent of the non users reported to undergone similar training.

The different trainings given to farmers were related to food security, mitigation to shock, modern irrigation management, marketing system and natural resource conservation. However, out of the total respondents who undergone different trainings, nearly 60% received training on modern irrigation management and 70% of the irrigation users and 43% of the non-irrigation users reported to undergone training on modern irrigation management. This is quite significant achievement in terms of acces to modern irrigation management trainings which would have much influence on the efficiency and effectiveness of the irrigation scheme.

Table 4.24: HHs access to training

Description	Did you get Training?		
	Yes	**No**	**NA**
Irrigation users	182 (84.265)	11 (61.11%)	2 (100%)
Non-users	15.74%	7 (38.89%)	0 (0%)
Total	**216 (91.53%)**	**18 (7.63%)**	**2 (0.85%)**

Source: survey result

Table 4.25: Opinion of HHs on type of training they received

Description	Type of Training Taken	Number of HHs	Percent
Users	Food security	3	1.54
	Mitigation to shock	4	2.05
	Modern irrigation management	136	69.74
	Marketing system	1	0.51
	Natural resource conservation	45	23.08
	OS	4	2.05
	OT	2	1.03
Total		**195**	
Non-users	Food security	10	24.39
	Modern irrigation management	5	12.2
	Marketing system	2	4.88
	Natural resource conservation	17	41.46
	OS	4	9.76
	TF	3	4.88
Total		**41**	

Source: survey result

With regard to DA support, the study result showed that 93.6 percent of the surveyed households' recived DA support (Table 4.26). When we see access to DA support by irrigation users and non-users,

95% users and 85% non-users reported to receive DA support. Thus 95.38 percent of the users and 85.37 percent of the non users confirmed that they get DA support. In line with this, when asked to rate the DA suppprt, 98 % of the surveyed households rated the DA support as good, with 100% of users and 98% of non-users rating the DA support as good (Table 4.26).

On the other hand, the frequency of contact with DA is reported to be five times with in a month by 64.8 precent of the surveyed households while 10.2 percent of the surveyed household reported has having no contact with Das with in a month period. Comparing the users and non users, 65.64 percent of the users and 60.98 percent of the non users have reported to have more than five times contact with the DAs (Table 4.27).

Table 4.26: Opinion of HHs on DA support and Technical assistance

Description	Response by surveyed HHs	Yes	No
Did you get DA Support?	Irrigation users	186 (95.38%)	9 (4.62%)
	Non-users	35 (85.37%)	6 (14.63%)
	Total	**221(93.64%)**	**15 (6.36%)**
Is technical DA support good?	Irrigation users	191 (97.95%)	4 (2.05%)
	Non-users	41 (100%)	0 (0%)
	Total	**232 (98.31%)**	**4 (1.69%)**

Source: survey result

Table 4.27: Frequencty of contact by DA

Response	Frequency of contact by DA			
	Never	**Up to two times**	**Up to five times**	**More than five times**
Users	18 (9.23%)	10 (5.13%)	128 (65.64%)	39 (20.0%)
Non-users	6 (14.63%)	4 (9.76%)	25 (60.98%)	6 (14.63%)
Total	**24 (10.17%)**	**14 (5.93%)**	**153 (64.83%)**	**45 (19.07%)**

Source: survery resul

With regard to credit service, nearly 78 percent of the respondents confirmed that they have access to credit services. Although both users and non user reported to have access to credit services, nevertheless, more of the users (81.5%) have better access to credit services as compared to non users (54%)-Table 4.28. In the same development, 74% of the surveyed households reported to access the credit on demand; with 80% and 49% users and non-users have the opinion that they access the credit services on demand/time (Table 4.29).

Similarly, 77.5 percent of the surveryed households have access to improved seed; with 82.56 percent of users and 53.66 percent of non users reported to have acess to improdved seed varieties. When asked on how they access the improved seed, e 95%t of the surveyed households reported to access the improved seed through purchase while only 5.1 percent of surveyed households reported to access the improved seed for free. Comparing users and non-users, only 6.15 percent of the users got improved seed for free while considerable percentage of users (94%) and non-users (100%) got the improved seed on purchase (Table 4.28).

On the other hand, the price of seed was reported to be reasonable by 66.1 percent of the surveyed households; with 69% of users and 51% non users reported the price of the improved seed as fair or reasonable while 31 and 49% of users and non-users have the opinion that the price of the improved seed was not fair or reasonable, respectively (Table 4.28).

Table 4.28: Opinionof HHs on credit services and seed prices

Descripition	Response by Surveyed HHs	Yes	No
Credit Service			
Did you get credit services?	Irrigation users	159 (81.54%)	36 (18.46%)
	Non-users	22 (53.66%)	19 (46.34%)
	Total	**181 (76.69%)**	**55 (23.31%)**
Seed Availability? Yes/No			
Did you get seed?	Irrigation users	161 (82.56%)	34 (17.44%)
	Non-users	22 (53.66%)	19 (46.34%)
	Total	**183 (77.54%)**	**53 (22.46%)**
How do you get seed? for free/ on purchase			
Did you get seed for Free/Purchase		**Free**	**Purhase**
	Irrigation users	12 (6.15%)	183 (93.85%)
	Non-users	0 (0%)	41 (100%)
	Total	**12 (5.08%)**	**224 (94.92%)**
Seed Price			
Is price of seed reasonable?	Irrigation users	135 (69.23%)	60 (30.77%)
	Non-users	21 (51.22%)	20 (48.78%)
	Total	**156 (66.10%)**	**80 (33.90%)**

Source: survey result

Table 4.29: Opinionof Irrigation users on access to credit on time

Responses	Did you get enough credit timely?		
	Yes	**No**	**NA**
Irrigation users	155 (79.49%)	5 (2.56%)	35 (17.95%)
Non-users	20 (48.78%)	2 (4.88%)	19 (46.34%)
Total	**175 (74.15%)**	**7 (2.97%)**	**54 (22.88%)**

Source: survey result

4. 6. Access to bank and credit service

Table 4.30 below showed that 80.93 percent of the respondants have reported to have saving account. Majority of the surveyed households receive banking services from farmers association. In line with this, 73.3 of the respondant reported to receive banking services from farmers associations. The other financial institutions available for banking services is Dedebit credit and saving Institution (DCSI) in which 52.5 percent of the respondants have reported to use it. However, the survey result indicates that majority of the surveyed households do not receive banking services from the state bank, private bank and cooperatives.

The study resulted that 72.9 percent of the respondans recived credit. Comparing the users and the non users, only 77.44 percent of users and 51.22 percent of non users have recived credit. Of the household interviewed only 32.6 percent have saving account in formal banks while 67.4 percent do not. Only 39.45 percent of the users have saving account in formal banks but non users do not.

On the other hand, the study revealed that only 5.1 percent of the respondants have saving account in informal financial institutions while 94.9 percent do not. 5.13 percent of users and 4.88 percent of non users do have saving account in informal bank institutions. More over the study result has showed only 1.7 percent of the respondant do lent money to others but 98.3 percent do not lent money at all (Table 4.30)

With regard to saving money 72 percent of the respondants do not save money in any of the bank institutions while 28 percent of the respondants save an amount of Birr 1,200.00 to 60,000.00. More of the respondants which is 5.5 percent of the respondants have saved Birr 20,000 (Table 4.30). Comparing the users and the non users, 66.15 percent of users and 100 percent of non users do not have saved money in any of the bank institutions.

Table 4.30: Banking and bank services

Descripition		Yes		No	
		No. HHs	Percent	No. HHs	Percent
Do have saving Account?		191	80.93	45	19.07
Type of bank the respondents use?	Dedebit credit and saving Institution(DCSI)	124	52.54	112	47.46
	State bank			236	100
	Private bank	NA	NA	NA	NA
	Farmers association	173	73.31	63	26.7
	Cooperative			236	100
Type of bank service the respondents got?	Recived ciredit	172	72.88	64	27.12
	Saving Acc/ formal	77	32.63	159	67.37
	Saving Acc/ Informal	12	5.08	224	94.92
	Lent money	4	1.69	232	98.31

Source: survey result

4. 7. Food security status of households by access to irrigation

According to PASDEP, the level and distribution of poverty in Ethiopia is declining from time to time and a remarkable economic growth has been observed. According to the results obtained from the 1999/00 Household Income, Consumption and Expenditure Survey and Welfare Monitoring Survey of the Central Statistical Agency (CSA), about 44 percent of the total populations (45 percent in rural areas and 37 percent in urban areas) were found to be below poverty line, while the 2004/05 surveys showed that 39 percent of the total population were under the poverty line out of which 39 percent in rural areas and 35 percent in urban areas. The interim report on poverty analysis study prepared by MoFED using the 2010/11 HCES and WMS reveals that the poverty line declined to 29 percent.

In view of the above compelling fact at national level, the study showed that only 14.4 percent of the household do have food shortage; with only 11 percent of users and 32 percent of non users found to have food shortage as depicted in table 4.31 below.

Table 4.31: Opinion of HHs on food shortage

Response by surveyed HHs	Do you have food shortage?	
	Yes	**No**
Irrigation users	**21 (10.77%)**	174(89.23%)
Non-users	**13 (31.71%)**	28(68.29%)
Total	**34(14.41%)**	**202(85.59%)**

Source: survey result

On the other hand, the survey result (table 4.32) disclosed that 88.6 percent of the respondants have enough food to cover all year need in 2003 EFY while only 11.4 percent of the surveyed households reported not to have enough food to cover all year needs. The resons for not having enough includes shortage of land, low production due to hazard, and lack and/or shortage of oxen in their order of importance (Table 4.33).

Table 4.32: Opinion of surveyed HHs on access to enough food

Did you get Enough food?	Irrigation user	Count	%
Yes	Irrigation users	181	92.82
	No-non users	28	68.29
	Total	209	88.56
No	Irrigation users	14	7.18
	Non-users	13	31.71
	Total	27	11.44

Source: survey result

Table 4.33: Reasons for not having enough food

List of reasons	Response (All HHs)	Count	%
Low production due to hazards such as hailstorm, flood, etc	Yes	0	0.00
	No	4	9.76
	Total	4	1.69
Land shortage	Yes	5	2.56
	No	4	0.00
	Total	9	3.81
Oxen shortage/lack	Yes	3	1.54
	No	0	0.00
	Total	3	1.27
NA	Yes	143	73.33
	No	19	46.34
	Total	162	68.64

Source: survey result

With regard to food assistance, the survey outcome in table 4.34 revealed that only 8.5 percent of the surveyed households receive food assistant and the most common type of assistant is cash/food transfer through food for work.Comparing users with non-users, only 8% and 12% respectively reported to receive food assistance in EFY 2003 which reveals that the surveyed households are in a relative better food security situation.

Table 4.34: Number of surveyed HHs who received food assistance

Response by surveyed HHs	Did you receive food assistant?	
	Yes	No
Irrigation users	15 (7.69%)	180 (92.31%)
Non-users	5 (12.20%)	36 (87.80%)
Total	**20 (8.47%)**	**216 (91.53%)**

Source: survey result

Table 4.35: Type of food assistance

Response by Survey HHs	Opinionof surveyed HHs on type of Assistant		
	Relief food through direct support	**Cash/food transfer through food for work**	**NA**
Irrigation users	3 (1.54%)	13 (6.67%)	179 (91.79%)
Non-users	0 (0%)	5(12.20%)	36 (87.80%)
Total	**3 (1.27%)**	**18(7.63%)**	**215 (91.10%)**

Source: survey result

4. 8. Copping strategies of households

Households in the study area have various copping mechanisms during crop failure. Table 4.36 below depited that the major coping mechanism adopted by the surveyed households includes eating less preferred food, eat fewer meals per day, looking for daily work outside farm, sales of livestock, borrow cash or grain from others, use reduced quantity of food per meal and sales of productive asset in their order of importance.

The survey disclosed that 11 and 73 percent of users and non-users respectively use eating less preferred food as best copping mechanism during times of food shortage caused due to crop failure followed by eating fewer meals per day as reported by 8 and 27 perent of users and non-users respectively (Table 4.36). From the survey, it can be concluded that surveyed households were not using negative coping mechanism such as sales of productive asset and use seed stock.

Table 4.36: Copping mechanisms adopted by HHs during crop failure

S/N	List of coping mechanism	Adoption of coping mechanism by users and non-users						Rank
		Irrigation users		Non-users		Total HHs		
		Count	%	Count	%	Count	%	
1	Sold productive assets	2	1.03	0	0.00	2	0.85	7
2	Eat food that normally they don't eat	1	0.51	2	4.88	3	1.27	6
3	Eat less preferred food	21	10.77	30	73.17	51	21.61	1
4	Looking for daily work outside the farm	16	8.21	7	17.07	23	9.75	3
5	Borrow cash or grain from others	5	2.56	0	0.00	5	2.12	5
6	Eat fewer meals per day	15	7.69	11	26.83	26	11.02	2
7	Use reduced quantity of food per meal	1	0.51	2	4.88	3	1.27	6
8	Sales of livestock	11	5.64	4	9.76	15	6.36	4

4.9 Assessment of overall welbien status

In this regard, the wealth status of the surveyed households has been categorized in to three based on community won wealth ranking status. Accordingly, 41.1, 48.3 and 10.6 percent of the surveyed households have been categorized as rich, medium and poor in accordance with local wealth ranking statushouseholds have medium Status of living, 41.1 percent are rich and 10.6 percent are poor (by Interview)-Table 4.37.

Table 4.37: Local Wealth ranking status

Response by surveyed HHs	Local wealth ranking		
	Rich	**Medium**	**Poor**
Irrigation user	97 (49.74%)	84 (43.08%)	14 (7.18%)
Non-users	0 (0%)	30 (73.17%)	11 (26.83%)
Total	**97 (41.1%)**	**114 (48.30%)**	**25 (10.59%)**

Furhtermore, as depicted in Table 4.38, surveyed households have been asked to assess their welbeiing starting 2001 to 2004 EFY. As per the self assessment result of the study, there were 115 irrigation users doing well in 2000 EFY and those who performed well increased to 179 households in 2004. Similarily, there were 3 non irrigation user households doing well in 2000 EFY and inceased their number to 28 in 2004 EFY.

Table 4.38: Welbeing self assessment

Year (EFY)	Response by surveyed HHs	Status Wellbing				Total
		Doing Well	Doing Just Okye	Struggle	Unable to meet HHs need	
2004	Irrigation users	179	13	2	0	194
	Non-users	28	12	0	0	40
	Total	207	25	2	0	234
	%	**0.88**	**0.11**	**0.01**	**0**	
2003	Irrigation users	177	16	3	0	196
	Non-users	26	14	0	0	40
	Total	203	30	3	0	236
	%	**0.86**	**0.127**	**0.013**	**0**	
2002	Irrigation users	155	32	8	0	195
	Non-users	17	20	3	0	40
	Total	172	52	11	0	235
	%	**0.73**	**0.22**	**0.05**	**0**	
2001	Irrigation users	115	58	20	5	198
	Non-users	3	23	12	0	38
	Total	118	81	32	5	236
	%	**0.5**	**0.34**	**0.14**	**0.02**	**1.00**

Source: survey result

4. 10. Improvement in livelihood Status

Many scholars found significant relationship between access to irrigation and improvement in overall livelihood status of target households. In this regard, the survey result (table 4.39) disclosed that over 95 percent of the irrigation users have reported increament in crop production in EFY 2004 as a result of

participation in the irrigation scheme while 75 percent of non-users also reported increase in crop production using rainfed agriculture too. On the other hand, significant proportion i.e is 72% of irrigation users have reported better livestock holding compared to non-users, 30% who reported increase in livestock holding in EFY 2004.

Similalry, with regard to ownership of other productive assets, higher number of irrigation users reported to own other assets as compared with the non-users.

With regard to income, 98% of users and 801% of non users reported increased income in EFY 2004 indicating higher number of users who reported increment in income which is attributed to ther access to irrigation facilities. On the other hand, increament in food consumption were reported by 92% users and 78% non-users.

Table 4.39: Improvement in livelihood of surveyed households

S/N	Livelihood indicators	Response by surveyed HHs	Levels of improvement					
			Increase		Decrease		No change	
			Count	%	Count	%	Count	%
1	Crop production	Irrigation users	186	95.38	0	0.00	9	4.62
		Non-Users	31	75.61	1	2.44	9	21.95
		Total HHs	217	91.95	1	0.42	18	7.63
2	Livestock holding	Irrigation users	141	72.31	1	0.51	53	27.18
		Non-Users	12	29.27	4	9.76	25	60.98
		Total HHs	153	64.83	5	2.12	78	33.05
3	Other asset ownership	Irrigation users	191	97.95	0	0.00	4	2.051
		Non-Users	33	80.49	0	0.00	8	4.103
		Total HHs	224	94.92	0	0.00	12	5.08
4	Income	Irrigation users	192	98.46	1	0.51	2	1.03
		Non-Users	33	80.49	2	4.88	6	14.63
		Total HHs	225	95.34	3	1.27	8	3.39
5	Food Consumption	Irrigation users	180	92.31	11	5.64	4	2.051
		Non-Users	32	78.05	0	0.00	9	21.95
		Total HHs	190	80.4	23	9.8	23	9.8

Chapter Five: Summary, Conclusion and Recommendation

This section summarizes the major findings of the study and proposes recommendations for policy purpose. Section 5.1 is Summary and Section 5.2 is Conclusion and Recommendations.

5.1. Summary

The aim of this study is to identify the impact of small scale irrigation on household food security and also to assess other related issues such as market, credit service, etc. Out of the 236 sample households 195 of them are irrigation users and the rest 41 are non users. The land holding of the sample household varies from 0.1 ha to 0.75 ha; the average land holding being 0.75 ha. With regard to access to natural resources, the study revealed that 44.5 percent of the households have access to use of natural resources.That is 43.59 percent of users and 48.78 percent of non uses have access to natural resources.

The study showed that 97.5 percent of the surveyed household confirmed that land distribution was not done in the last 5 to 10 years. Only 2.5 percent of the surveyed households' reported that land distribution was made in irrigated land. In line with this, 35 percent of the surveyed household reported that land distribution has affected the agricultural investiment activities in the area.

With regard to ownership of oxen, 84.62 percent of the irrigation users and 53.66 percent of non users have one and more ox implying that irrigation usres have higher ox holding than non user households.

Under the rainfed agriculture, the study revealed that 84.3, 70.3, 18.2, and 83.1 of the surveyed households use chemical fertilizers, organic fertilzers (manure), improved seed and pecticides respectively.

Under the irrigation agriculture, the study revealed that 70.33, 0.85, 3.39, 69.5, 83.1 percent of the surveyed households use chemical fertilzers, manure, local seeds, improved seeds and pesticides respectively.

The average distance to the market place in kilometer for the sample households is found to be 7.2 km with a minimum of 6 km and a maximum of 8.4 km. The average for households with access to

irrigation is 7.3 km while the non user households have a better access to the market place which is 6.1 km.

The study revealed that 89.8 percent of the respondents sale their produce by taking the produce to the market and 89.8 percent sale the produce as an individual. 58.9 percent of the respondents confirmed that they do have selling/ marketing problem. 59.3 percent of the respondents indicated that the marketing problem is related with low price of produce. In line wih this, 15.7 percent of the respondents reported that the effort made by the government in creating good market access is low.

In relation to extension support, 93.2 percent of the surveyed households' access to irrigation support with 95.4% and 83% of the users and non-users reported to access extension services respectively. The study result showed that 55.1 percent of the sample households indicate the extension support they received is good. When comparing irrigation user and non user households, majority of the user households get support from extension agents when compared to non users. According to the survey 55.38 percent users and 53.56 percent non users received good extension support/ service.

With regard to training, 91.5 percent of the respondants took differet trainings. Of the 195 irrigation users, 93.3 percent of them have taken different trainings. Similarily, 83 percent of the non users' received training. The different trainings given to farmers were related to food security, mitigation to shock, modern irrigation management, marketing system and natural resource conservation. Among the surveyed households who received training, 60 of them undergone training on modern irrigation management. Similalry, amongh the irrigation users, 70% have trained in modern irrigation management and 42.5 percent of the non users trained in natural resource management.

The study result found that 94 percent of the respondents' recived DA support constituting 95.38 percent of the users and 85.37 percent of the non users receiving DA support any time. In line with this, 98.3 percent of the respondants confirmed that the technical support from DA was good. Accordingly 97.95 percent of user and 100 percent of non users confirmed that the technical support from DA was good. Moreover, 64.8 precent of the household confirmed that the frequency of contact of DA is up to five times in a month and 10.2 percent said never. Comparing the users and non users, 65.64 percent of the users and 60.98 percent of the non users have more than five times contact with the DAs.

With regard to crdit service, 76.7 percent of the respondents confirmed that they get credit service. Both users and non user get credit service but more of the users, 81.53 percent get credit thatn non-users, 53.66 percent.

In relation to access to improved seed, the study revealed 77.5 percent of the households get the type of seed they want which constitute 82.56 percent of users and 53.66 percent of non users while 17.44 percent of users and 46.34 percent of non users do not get seed they want. 95 percent of the respondents indicate that they get the type of seed they want on purchase and only 5.1 percent of respondents indicate they get seed for free. Only 6.15 percent of the users get the type of seed they want for free but 93.85 percent of users and 100 percent of non users get the type of seed they want on purchase. In line with this, the study showed that 66.1 percent of the respondents confirmed taht the price of seed was reasonable while 40 percent said the price was not reasonable.

The study resulted that 80.93 percent of the respondants have credit access. The main source of credit in the study area is farmers association where 73.3 of the respondents have access. The other source of credit acces is found from Dedebit Credit and Saving Institution (DCSI), in which 52.5 percent of the respondants have credit access. As the result indicated the respondants do not have credit acess to state bank, private bank and cooperatives. The study resulted that 72.9 percent of the respondans received credit. Of the household interviewed only 32.6 percent have saving account in formal banks while 67.4 percent do not. Similarily only 5.1 percent of the respondents have saving account in informal financial institutions while 94.9 percent do not. Moreover, the result indicated that only 1.7 percent of the respondent lent money to others but 98.3 percent do not lent money at all.

Households in the study area have various copping mechanisms during crop failure. Table 4.36 below depited that the major coping mechanism adopted by the surveyed households includes eating less preferred food, eat fewer meals per day, looking for daily work outside farm, sales of livestock, borrow cash or grain from others, use reduced quantity of food per meal and sales of productive asset in their order of importance. The survey also showed that rent out farm land is the less exercise coping mechanism where only 0.8 percent of the households and 1.03 percent of non users used. In conclusion,

the study revealed that none of the households do depend on negative coping mechanism such as sales of seed stock, withdraw children from school, distressed migration, sale of household assets and renting out of land.

In relation to food sufficiency of the household, the study found that 14.4 percent of the surveyed households do have food shortage with only 11 percent of users and 32 percent of non users have food shortage. In essence, it can be drawn that 85.6 percent of the respondents have enough food. The reasons for not having enough food are land shortage, low production due to hazards such as hailstorm, flood, etc, and oxen shortage.

With regard to food assistance, the study indicated that only 8.5 percent of the households received food assistant and most common type of assistant is cash/food transfer through food for work. In relation to the food assistance, more than 92 percent of the users and 88 percent of the non users do not get food assistant. The study also revealed that 0.8 percent of the households migrate to over common the food insecurity situation.

As per the interview made with the respondents to show their relative wealth ranking with in the community, using community own wealth ranking, the study disclosed that 41.1, 48.3 and 10.6 percent of the surveyed have been rated as rich, medium and poor. Similalry, wealth ranking among the irrigation users realed that 49.74 percent rated as rich, 43.08 percent as medium and 7.18 poor. Similarily, among the non users, 73 and 27 percent were rated as mediumand poor in their wealth ranking respectively.percent responded they are medium and 26.83 percent poor.

5.2. Conclusions and Recommendations

From the study the following concluding remarks and policy options can be drawn.

The survey result disclosed that over 95 percent of the irrigation users have reported increament in crop production in EFY 2004 as a result of participation in the irrigation scheme while 75 percent of non-users also reported increase in crop production using rainfed agriculture too. On the other hand, significant proportion i.e is 72% of irrigation users have reported better livestock holding compared to non-users, 30% who reported increase in livestock holding in EFY 2004. Similalry, with regard to

ownership of other productive assets, higher number of irrigation users reported to own other assets as compared with the non-users.

With regard to income, 98% of users and 801% of non users reported increased income in EFY 2004 indicating higher number of users who reported increment in income which is attributed to ther access to irrigation facilities. On the other hand, increament in food consumption were reported by 92% users and 78% non-users.

In essence, irrigation users were performing better in terms of improvement in livelihood which has been explained profoundly with only 11% of the users reported to have food shortage and in response enrolled in food assistance programs in EFY 2004 as compared to 32% non-users.

The irrigation users were better positioned in terms of their access and use of extension services, credit facilities, agricultural inputs and trainings which has be reflected in their food security status.

However, there were key institutional drawbacks noted by both irrigation users particularly in terms of creating market access and market information both for input and output marketing which needs to be addressed via innovative and robust institutional arrangement. Besides, low financial status of irrigation users have also impact on effectiveness of the irrigation schemes particualry lack of money to buy improved seed, pesticides, fertilizers and oxen have significant impact on performance of the irrigation users and non-users too.

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7. Annexes