THE CONTRIBUTION OF SMALL SCALE IRRIGATION TO HOUSEHOLDS' INCOME AND FOOD SECURITY: THE CASE OF GAMBELA TERE IRRIGATION SCHEME, EAST WELLEGA ZONE OF OROMIA

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June 2011

Addis Ababa

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A Thesis Submitted to Addis Ababa University in Partial Fulfillment for the Degree of Master of Science in Food security studies (FSS)

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ACKNOWLEDGEMENTS

Several individuals and organizations deserve acknowledgement for their contributions to the study. I am greatly indebted to my advisor Terefe Degefa (PhD) for his unreserved help, advice, insightful guidance, and support he rendered me.

Getachew Adugna (PhD) with his family is my backstop throughout my life.

Special thanks to Addis Ababa University for giving me the fund for study.

My heartfelt thanks go to Ato Fikiru Hajilu for his encouragement and providing me his Lap-Top until I accomplished writing the report of this study

My special thanks are given to my wife, W/ro Aykifash Teferra and my children Hunde, Saron, Feven and Diborah Girma for their invaluable encouragement and patience throughout the course of my study.

I express my thanks to Ato Megersa Geleta, Yetneberk Geremew, Kibru Alemayehu, W/ro Hirut Ayalew and Ato Abera Dinku for their all rounded friendly supports.

I am also grateful to Ato Gemechisa Yadeta and all Gobu Seyo Wereda Agricultural Development Office staff for their facilitation of the situations to undertake the survey.

My special gratitude goes to enumerators, the members of the sample farm households, and key-informants for their valuable cooperation during data collection activity in the area.

I wish to acknowledge Ato Abebe Diriba of Oromiya Regional Bureau of Agriculture for facilitating the conditions for my study.

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LIST OF Acronyms

AE	Adult Equivalent
CSA	Central Statistical Authority
CTA	Centre for Agricultural and Rural Cooperation
DAs	Development Agents
EHNRI	Ethiopian Health and Nutrition Research Institute
FANTA	Food and Nutrition Technical Assistance
GoE	Government of Ethiopia
GOs	Government organizations
GTP	Growth and Transformation plan
GWADO	Gobu Seyo Wereda Agricultural development office
HH	House Hold
HoA	Horn of Africa
IDD	Irrigation Development Department
IFAD	International Fund Agricultural Development
IFPRI	International food policy research institute
IWMI	International Water Management Institute
KAs	Kebele Administrations
Kcal	Kilocalorie
MDP	Millennium Development Goal
MoA	Ministry of Agriculture
MoWR	Ministry of Water Resource
NGOs	Nongovernmental Organizations
OIDA	Oromia Irrigation Development Authority
SPSS	Statistical Package for Social Science
SSI	Small Scale Irrigation
TLU	Tropical Livestock Unit
UNDP	United Nations Development Progrm
USAID	U.S. Agency for International Development
WFP	World Food Program
WUA	Water Users Association

ABSTRACT

The purpose of this study was to analyze the contributions of small scale irrigation to household food security and income and to describe factors affecting the small scale irrigation schemes. The study was conducted in Gobu Seyo district on GambelaTere small scale irrigation scheme. To achieve the objective the study both quantitative and qualitative methods were used that employed descriptive survey approach. Data were collected from 150 household heads (75 irrigation users and 75 none users) through questionnaire, which were drawn by simple random sampling technique. In addition, household field observation, Focus Group Discussions and key informant interviewswere used to collect data. To get the food security status of households, a modified form of a simple equation termed as Household Food Balance Model, originally adapted by Degefa (1996) from FAO was applied. The findings of the study highlights that there is a positive impact of irrigation because it brings increased agricultural production and productivity, which in a way improves food security situation income and asset building. Regarding food security, irrigation users are in a better position in food access, utilization and availability. Irrigation users are also in a better position in dietary frequency and diversity. About 76% irrigation users were food secured (get >2100 kcal) while only 49.5 % of none irrigation users were food secured. Irrigation, resulting in generating more income, the income of irrigation users is more than double of none irrigation users. The household asset of irrigation users has increased by 422%. Furthermore, some of the factors affecting small scale irrigation were found to be skill gap in utilization of irrigation agronomy, instability of market, shortage of labour and lose of water and poor maintenance of infrastructures. It has been, therefore, concluded that small scale irrigation development contributes for income and food security of beneficiary households. Thus, the concerned government organizations and none-governmental organizations should join hands to support the development of such small scale irrigation schemes. Linking the farmers with marketing system, training on irrigation agronomy, promotion of post harvest technology and making the users aware of effective and efficient utilization of water irrigation management has paramount contribution in food security in income improvement.

Chapter One

INTRODUCTION

1.1Background of the study

The number of undernourished people in the world is 925 million in 2010. Developing countries account for 98 percent of the world's undernourished people (FAO and WFP, 2010). According to FAO's reports (2010), approximately 33 percent of the population in Sub-Saharan Africa is undernourished. The reports also indicate that there are 307 million hungry people in Africa, with most of these living in Sub-Saharan Africa (265 million). More than 40 percent of the population in the Horn of Africa (HoA) is undernourished and millions are food insecure (WFP, 2010).

Ethiopia has a population of over 80 million people, and a GDP per capita currently estimated at about US$ 360. The agriculture-based economy of the country accounts for about 40% of national GDP, 80% of exports, and 80% of total employment. Agricultural production of the country remains mainly rainfed at a peasant smallholder producer level (FAO, 2011).

Despite Ethiopia's agricultural enterprises, a high and growing human population, recurrent droughts and periodic floods, complicated by climate change that has been accompanied by severe soil and landscape degradation in some regions contributed to a situation of national food insecurity (FAO, 2011). As the result, Ethiopia's striking diversity and the equally diverse challenge it poses have led the government to adopt the valuable conception of 'Three Ethiopians'; these are: Productive Ethiopia, Pastoral Ethiopia and Hungry Ethiopia. 'Productive Ethiopia' (estimated to be about 45 million people) has the potential to increase food availability and thus reduce prices. The challenge of 'Pastoral Ethiopia' (estimated at about 12-14 million) is to maximize productivity and increase resilience to shock (mainly drought) without upsetting the environmental equilibrium is so essential to food security in pastoral areas. 'Hungry Ethiopia' (estimated at about 15-20 million) includes households with small farms on degraded soils and limited means of production (FAO, 2011). This shows that Ethiopia is one of the countries currently with some 46% of the population classified as "undernourished" (WFP, 2010).

Agriculture in Ethiopia is heavily dependent on rainfall, which is highly varies both spatially and temporally. In many parts of Ethiopia, agricultural development is hampered by recurrent droughts, which over the years have increased both in frequency and severity in many parts of the country. In the past 30 years, the drought incidence has become common pattern every two to three years (FAO, 2008). This, therefore, calls for different interventions, irrigation being one of the options, which could help in adapting strategies to cope up with the challenging drought.

Irrigation enhances agricultural production and improves food supply and income of rural population, opens employment opportunities for the poor, supports national economy by producing industrial crops that are used as raw materials for value adding industries and exportable crops (Mekonen and Seleshi, 2008). It is therefore mandatory to adapt new schemes based on sound principles and techniques for efficient water use and for optimizing irrigation in relation to all other essential agricultural inputs and operations (FAO, 1987). The vital task of increasing and stabilizing food production in drought-prone regions must therefore include a concerted effort to improve on-farm water management. Some traditional irrigation schemes need to be modernized so as to achieve higher yields as well as better resource utilization.

Recognizing these facts, while small scale irrigation and rainfed agriculture water management are undertaken by regional government, medium and large scale irrigation developments have been given significant attention by the federal government and the Ministry of Water Resources in its development program (IWMI, 2005). Under the title "Irrigation Infrastructures Development for Food Security and National Economic growth" the Ethiopian government started an irrigation development program in order to meet the ambitious efforts of the 15 years Water Sector Development Program, which is scheduled from 2002 until 2016. The investment in large-scale irrigation projects should guarantee to meet the demands for industrial raw materials for Agro-industries, cash crops and food crops (IWMI, 2005).

Irrigation is highly expected to play a major role in the realization of Ethiopian food security and poverty alleviation strategy. It is from this expectation that the Growth and Transformation Plan (2010/11-2014/15) of the country has given priority to irrigation development. In irrigation sub-sector, the country is believed to have the potential of 5.1 million hectares of land that can be developed for irrigation through pump, gravity, pressure, underground water, water harvesting

and other mechanisms. Thus, irrigation development, particularly small scale irrigation will be accelerated (MoFED, 2010).

Though irrigated agriculture has positive impact on household food security and income (Fuad, 2002; Desta, 2004) there are cases where irrigated agriculture failed to achieving intended impact on household wellbeing (Quasem, 1994). (Dessalegn, 1999) also confirms that though small-scale irrigation for semi-cash cropping schemes cover more than 40% of the irrigated land in the country, the contribution of farmer based schemes have not been studied. This implies that the impact of irrigation on individual farm household in terms of food security of small-scale irrigation need to be well studied and documented (Wagnew, 2004). As Seleshi et al (2005) explain, the need for undertaking impact assessment of small-scale irrigation particularly on household food security has paramount importance.

1.2 Statement of the Problem

Recurrent drought is the most catastrophic natural event affecting food security in Ethiopia. It highly results into widespread crop failure and periodic famine in many parts of Ethiopia. To alleviate the impact of repeated drought and to increase production, expansion of irrigated agriculture is considered to be a priority in the agricultural transformation and food security strategy of the Ethiopian Government. In line with this objective, the Federal Government, Regional States and NGOs have been promoting irrigation development schemes so as to increase food production in the country (Haile, 2008).

Oromia is the largest state in terms of both population and land area. It covers a total geographical area of about 355,000 km^2. According to CSA (2007), Oromia has a total population of 27,158,471 out of which 23,788,431 (85.83 percent) of the population is estimated to be rural inhabitant, while 3,370,040 (14.17 percent) is urban inhabitant. This data proves that majority of the population of the region reside in rural area depending on agriculture, which demands the regional state to revisit its irritation schemes to secure food production, though it has being involved in irrigation development so far.

Currently, there are 199 irrigation schemes in the region that covers 33,765.19 hectares of irrigated area of which 4,627.29 hectare is for small-scale, 2,800.01 hectare for medium-scale,

and 26,338 hectare for large-scale irrigation scheme that benefits 37,479 people (Seleshi et al, 2007).

Gambela Tere irrigation scheme is among those small-scale irrigation schemes found in Gobu Seyo Wereda in Ongobo Kebele Administration. Out of 612 households in the area, 225 households are users of the irrigation scheme. The scheme has been established in order to improve the livelihood of the area. To the researcher's knowledge, however, there are no empirical findings to witness whether or not the farmers have been benefited from the irrigation scheme. It is, therefore, advisable to assess the contribution of such small-scale irrigation to food security and income of the beneficiary households in terms of improving livelihood.

It is from this belief that this study envisaged to generate empirical evidences on the role of small-scale irrigation in enhancing rural household food security. At the same time to contribute to the existing knowledge and understanding of development actors in their future planning and development of small-scale irrigation schemes. To this end, the study attempts to answer the following basic research questions:

1. What contribution is being made by the irrigated agriculture to improve household food security?

2. What is the status of household food security in the study area?
3. What are the factors affecting small scale irrigation?

1.3Objective of the Study

The main objective of this research is to investigate the contribution of small-scale irrigation to household income and food security while the specific objectives of the research include:

1. To assess the contribution of irrigated agriculture to households' food security;

2. To assess households' food security status of the study area;

3. To identify factors affecting small scale irrigation

1.4 *Significance of the Study*

The findings of this study are expected to benefit

- local government;
- development practitioners;
- policy makers;

in terms of improving the knowledge base for impact of irrigated agriculture on enhancing households' income and food security. On top of this, the findings of the research work gives insight for researchers and students interested in similar research theme for further investigation of the contribution of irrigation for improved household livelihood.

1.5 *Scope and Delimitation of the Study*

This research study is conducted to assess the contribution of the irrigated agriculture to households' food security and income. The study was delimited to one irrigation scheme located in Ongobo Kebele Administration located in Gobu Seyo wereda in East Wellega Zone of Oromia Region. Irrigation impact assessment requires a much more complex, dynamic and also requires multidisciplinary approach which uses different criteria based on interest of groups, disciplines, professions and values. This study, however, is delimited only to investigate the contribution of irrigation to household food security and income.

1.6 *Organization of the Thesis*

The thesis is organized in five chapters. The first chapter deals with issue related to background of the study, statement of the problem, objectives, significance and delimitation of the study. Chapter two provides overview of the conceptual framework of irrigation and its contribution to household food security, concepts, measurements and indicators of food security and improved income and development of irrigation in Ethiopia. Chapter three provides information on the research method employed and background information on the study area. Chapter four is dedicated to the presentation, analysis and interpretation of data gathered through different data collection instruments. The last chapter, chapter five, presents conclusions and recommendations.

Chapter Two

REVIEW OF THE RELLATED LITERATURE

2.1. Irrigation Development

2.1.1. Definition

Different authors and organizations define irrigation in various ways depending upon the conceptual perception of the definer. FAO (2009:) defines irrigation as: "Irrigation is the supply of water to agricultural crops by artificial means, designed to permit farming in arid regions and to offset the effect of drought in semi-arid regions and even in areas where total seasonal rainfall is adequate on average; it may be poorly distributed during the year and variable from year to year".

This means irrigation is a means by which agricultural production could be supported by maintaining moisture and supplying additional water to the farm land. It is a way of overcoming the effects of drought, shortage of rainfall and moisture stress. According to the quotation, irrigation can also be used when adequate seasonal rainfall is scarce.

2.1.2. Contribution of irrigation to food security at global level

Irrigated agriculture is a vital component of total agriculture and supplies for many of the fruits, vegetables, and cereal foods consumed by humans. It is also equally important for the grains fed by animals, which are used as human food on top of feeding to sustain animals for work in many parts of the world (FAO, 2009).

Irrigation, according to many studies (FAO, 2003) is a vital component of agricultural production in many developing countries. In 1998, for instance, irrigated land made up about one-fifth of the total arable area in developing countries but produced two-fifths of all crops and close to three-fifths of cereal production (FAO, 2003). In 1997-99, irrigated land provided two-fifths of crop production in developing countries, and accounted for about one-fifth of the cultivated area. The divergence in these statistics reflects the high crop yields and multiple cropping that are achieved through irrigation (FAO, 2002).

Irrigation enables greater agricultural production than is achieved with rainfed agriculture. As indicated by FAO (2002), the additional food production obtained with irrigation is essential for food security on a global level, and on a national level for some countryside imports, but irrigated agriculture will be a major contributor. Irrigated agriculture will provide 57 percent of the additional 256 million tones of cereals that will be produced in 2025 relative to 1995. Moreover, irrigation increases agricultural production through both the expansion of cultivable area beyond that possible under rainfed agriculture leading to higher crop yields (FAO 2002).

Irrigation increases yields not only through reduction or prevention of crop water stress, but also through complementary benefits of combined use of irrigation with high yielding varieties, fertilizers and pesticides ('green revolution' technology). Yields for cereals produced with irrigation exceeded rainfed yields by 115% in developing countries collectively and by 150 % in sub-Saharan Africa and West Asia/North Africa in 1995. It tends to increase local fluctuations in crop production and food supplies, particularly affecting food supplies and incomes of poor people, and increased national vulnerability to food insecurity (FAO, 2003).

2.1.3. Irrigation development in Ethiopia

In Ethiopia, government intervention in irrigation development is a recent phenomenon though farmers of high land area practiced traditional irrigation for centuries (Woldeab, 2003). Imperial government in the 1950s through constructing water development projects initiated the development of water for irrigation purpose. The development was concentrated in the Awash valley as part of agro industrial development initiative. Later, it was gradually expanded to rift valley and the Wabishebele basin (Berhanu and Peden, 2003).

The development of modern irrigation has a relatively recent history in Ethiopia, whereas traditional irrigation has been in existence for longer periods. Traditional irrigation was initiated by farmers through gravity diversion from perennial sources/springs for growing cereals, fruits, and vegetables (CTA, 2003). However, 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. The Ethiopian Government started formal SSI in the early 1980s following the widespread drought that affected the country.

According to Dessalegn (1999), the main purpose of the introduction of irrigation development was to provide industrial crops to the growing agro-industry development where many of which were controlled by foreigners who were interested to boost export earnings. The same source indicates that, the Derge regime like its predecessors was keen to promote large scale and complex water projects. Initially, irrigation was seen as part of modernization and socialization of country's agricultural economy. Moreover, irrigation was considered as important investment for improving rural income through increased agricultural production and reduction of the growing pressure on land possession by cultivating unutilized land.

Later with recurrence and continued threat of drought, the justification for irrigation development expanded to include relieving drought, recurrent food shortage, and address the problem of food insecurity and nutritional problem of the population. In 1975, all large-scale irrigation schemes constructed during imperial regime were Nationalized and handed over to the Ministry of State Farm. Most of land lord owned small-scale irrigation schemes were handed over to producers' cooperatives (Berhanu and Peden, 2003).

Small-scale irrigation was given little attention during the Derge regime. It was only in the second half of the 1980s as a result of devastating famine of 1984/85 that the Derge begun to show interest in small-scale irrigation and accordingly established Irrigation Development Department (IDD) within Ministry of Agriculture (MoA) which was primarily responsible for the development of small scale irrigation in the country. With the change in government in 1994, IDD was dissolved and replaced by Regional Commission for Sustainable Agricultural and Environmental rehabilitation (Co-SAER).

The new organization, i.e. Co-SAER, has embraced the promotion of small-scale irrigation as a primary mandate (Wagnew, 2004). This current irrigation policy emphasizes on development of huge irrigated agricultural potential for production of food crops and raw materials for agro-industries. More specifically, development and enhancement of small-scale irrigated agriculture for food security at household level is given important place (MoWR, 2001).

There are various estimations in relation to irrigation potential in Ethiopia. However, the potential varies across regions. Oromia region accounts the largest, which is 1.7 million hectare out of

about 4.5 million hectare of land that has been estimated for potential irrigation in the country (Tilahun and Paulos, 2004).

2.1.4. Small scale irrigation

There could be great differences between countries and agencies over what is meant by "small scale" irrigation. Turner (1994), for instance, points out that irrigation system can be classified according to size, source of water, management style, degree of water control and type of technology. Carter (1991), on the other hand, explains that small-scale irrigation is 'Irrigation, usually on small plots, in which, farmers have the major controlling influence and using a level of technology, which the farmers can effectively operate and maintain'. This shows that classifying irrigation using scale varies from country to country. For instance, in India an irrigation scheme of 10,000 hectares is classified as 'small' while in Ghana, the largest irrigation scheme is 3000 hectares (Smith, 1998).

Dessalegn (1999) on the other hand groups irrigation schemes in Ethiopia into three, based on the scale: large-scale schemes, which can irrigate 3000 hectares of land and they are usually established and were run by the state; medium-scale schemes possibly irrigating an area of 200-3000 hectares of land and usually managed by state farms and parastatal enterprises. The third category is small-scale schemes irrigating up to 200 hectares of land mainly owned and managed by peasants organized into community groups or water-use associations.

Similar to Dessalegn, Dejene and Yilma (2003) also defined small scale irrigation project which set up on a command area of up to 200 hectares that have various advantages over medium and large-scale irrigation schemes. Among the advantages, small scale irrigations require lower investment cost, which can be managed by farming communities; there is no population displacement involved they do not involve construction of dams and reservoirs; they are less demanding in terms of management, operation and maintenance; they do not inflict land tenure and resettlement problems; they do not cause adverse environmental impact; they allow wider diffusion of benefits and they permit farmers to learn irrigation techniques at their own pace in their own way (Dessalegn,1999). Small scale irrigation is, therefore, seemed to be preferred to medium and large-scale irrigation due to the advantages it has.

Currently, small-scale schemes are becoming popular in Ethiopia. After establishment, small scale schemes are usually "handed over" to water use associations (WUAs) for management, operation and maintenance with the support of personnel from regional bureaus (Berhanu and Peden, 2003). This implies that the advantages of the scheme influenced the demand of the users as they can easily be benefited from without incurring huge cost, skill, and labor force.

2.1.5. Importance of irrigation to Ethiopia

As has been discussed under section 2.1.2, irrigation contributes to a better livelihood of households. As explained by Hussein and Hanjra (2004) irrigation enables farmers to increase crop production and achieve higher yields, and reduces the risk of crop failure if rain fails. In addition, irrigation also multiplies the positive effect of other inputs such as fertilizers and pesticides on crop yields. As the result, Ethiopia cannot be exceptional to utilize irrigation for the scheme contributes to improve income and food security of its citizens. More specifically, using irrigation enables small farmers (majority of the population) to diversify production from staples to include high value crops such as fruits, vegetables and cash crops which can be sold. Using appropriate irrigation scheme also increases production of fruit and vegetables that in a way also improves the household's own nutrition. There are also direct benefits for non-irrigation users because it initiates them to develop their awareness toward the use of irrigation to grape its advantages.

Food availability and affordability typically increase when irrigated agriculture expands and guarantees reliable production that help to stabilize food prices. It also creates new employment opportunities in farming that lead to wider rural economic development in turn leading to increased farm income directing to greater demand for both agricultural inputs and non farm goods and services (Hussein and Hanjra, 2004) Such contribution of irrigation improves the lives of the poor households. As explained by Lipton and Litchfield (2003) utilization of appropriate irrigation scheme can thus buffer both irrigators and non-irrigators against risks in their livelihood, preventing or reducing the need for last-resort coping strategies such as sale of assets or high-cost borrowing. Given the precariousness of rainfed agriculture and high frequency of drought, with disastrous impacts for millions of people, irrigation clearly has a role to play in securing rural livelihoods and improving food secu rity in Ethiopia.

2.2. Food Security

2.2.1. Food Security Definitions and Concepts

Food security is a concept that evolved over time. There are many definitions of food security. Among various definitions given by a number of experts, the most widely used definition of food security is given by the World Bank that reads as "access by all people at all times to enough food for an active, healthy life" (World Bank, 1986). In the definition given, the essential elements are the availability of food and the ability to acquire it. In this regard, Maxwell and Simth (1992) give details that there are four core concepts implicit in the notion of 'secure access to enough food at all times'.

(a) Access to enough food- defined by entitlement to produce, purchase, exchange food, or receive it as a gift. An individual's entitlement is rooted in his/her endowment - the initial resource bundle that is transferred via production and trade into food or commodities, which can be exchanged for food;

(b) Sufficiency of food- defined mainly as the calories needed for an active, healthy life in which the case is individual not about the issue of household; whereas household is aggregate of individuals in household whose food need has to be satisfied;

(c) Security- defined by the balance between vulnerability, risk, and insurance. The notions of risk and risk avoidance have been central to definition of food security since the term came into use in the 1970s;

(d) Time- where food insecurity can be chronic, transitory or cyclical.

In the mid 1970s, food security was conceived as adequacy of food supply at global antinational levels (Debebe, 1995). Attaining food self-sufficiency alone does not necessarily imply the achievement of food security. Many countries those used to be considered as self-sufficient in food were found to be food insecure because they lack either an efficient food system or the capacity to the level of food entitlement. This indicates that attaining macro level food self-sufficiency does not ensure the achievement of household food security (Getahun, 2003). Therefore, food security strategy has to address household-level food production through investment in food production and storage. The concept of household food security is a more

recent development and the bulk of literature dated from 1980s equating national food security with food self-sufficiency is a problem that needs to be clearly understood.

Food self-sufficiency is essential but not sufficient vehicle for solving household level malnutrition and household food insecurity problems (Rukuni, 2002). This means that food sufficiency at national level does not guarantee food sufficiency at household level. Debebe (1995) indicates that household food security mainly conditioned by factors, which are related to the process of acquisition, household procurement strategies and socio economic condition of the society. With regard to this, the key elements that are critical to household food security are availability and stable access.

Availability is further influenced by the different sources of food and handling patterns, which facilitate the time dimension of food availability in the household. Besides, household is identified as food secured if entitlements of demand for food security is greater than food needs, which is defined as the aggregation of individual requirements. At individual level, the definition is much more straightforward. An individual is food secured if his or her food consumption is determined by claim the individual has on household food source. This may be affected by individual earning or asset or by individual position in the household (Thomson and Metz, 1997).

Food entitlements (Sen, 1981) is defined as a set of alternative commodity bundles that a person can command in a society using a totality of rights and opportunities that he or she faces. This means, what a person can produce, buy or borrow or given or owns and what socially and state regulations allow him/her to do with that. Sen (1981) identified four main categories of entitlement: trade based entitlement, which describes what an individual can buy with the commodities and cash they own; production based entitlement, which describes the right to own what one produces with one's own resource; inheritance or transfer entitlement, which refers to the right to own what is willingly given by others as remittance, bequest, as well as transfer from state such as social security, pensions and food distribution. All these entitlements give an individual control over resource, which he/she can use.

In a broader way, Maxwell (2001:) defines food security, as "…a country and people are food secure when their food system operates in such a way as to remove that there will not be enough to eat. In particular, food security will be achieved when the poor and vulnerable, particularly

women and children and those living in marginal areas have secure access to the food they want…". This implies that food security can be achieved if individuals can obtain the necessary food without any problem or scarcity.

According to Emergency Food Security Assessment of WFP (2009), the analysis of food security is based on three pillars: (i) food availability; (ii) food access; (iii) and food utilization. Indicators for analysis of the three pillars are provided below:

Food Availability

Food availability is the physical presence of food in the area of concern through all forms of domestic production, commercial imports and food aid. Food availability might be aggregated at the regional, national, district or community level. In an EFSA manual tool, food availability is usually analyzed at the district and community levels. According to WFP (2009), food availability is determined by:

- Production: food produced in the area;
- Trade: food brought into the area through market mechanisms;
- Stocks: food held by traders and in government reserves;
- Transfers: food supplied by the government and/or aid agencies.

However, national and regional food availability may be considered when developing future scenarios and discussing response options.

Food Access

Food access concerns a household's ability to acquire adequate amount of food, through one or a combination of own home production and stocks, purchases, barter, gifts, borrowing and food aid. The following are some examples:

- Own production – crops, livestock, etc.
- Hunting, fishing and gathering of wild foods;
- Purchase at markets, shops, etc;
- Barter – exchange of items for food;

- Gifts from friends/relatives, community, government, aid agencies, etc.

Food may be available but not accessible to certain households if they cannot be acquired a sufficient quantity or diversity of food through these mechanisms.

Food Utilization

Food utilization refers to households' use of the food, to which they have access, and individuals' ability to absorb and metabolize the nutrients– the conversion efficiency of the body. Food utilization includes:

- The ways in which food is stored, processed and prepared, including the water and cooking fuel used, and hygiene conditions;
- Feeding practices, particularly for individuals with special nutrition needs, such as babies, young children, the elderly, sick people, and pregnant or lactating women;
- The sharing of food within the household, and the extent to which this corresponds to individuals' nutrition needs - growth, pregnancy, lactation, etc.;
- The health status of each member of the household.

Food may be available and accessible but certain household members may not benefit fully if they do not receive an adequate share of the food in terms of quantity and diversity, or if their bodies are unable to absorb food because of poor food preparation or sickness (WFP, 2009).

2.2.2. Food Security Indicators and Measurements

Food security is influenced by different socio-economic, environmental, and political factors. However, it is difficult to find a single indicator which is used to measure food security. Many different indicators are needed to capture the various dimensions at country, household, and individual levels (Hoddinnott, 1999). As a result, assessment of food security has become difficult and necessitated an approach ranging from a mere quantitative to a combination of quantitative and qualitative measurements (Debebe, 1995, Ayalew, 2003).

The use of selection of food security indicators depends on resource availability, namely; finance, personnel, institution and infrastructure. In situation, where there is shortage of such resources

and possibility of collecting primary data is difficult, reliance on secondary data collected by multiple agencies may be necessary.

The second criterion is the relevance and accuracy of indicators to be used. Relevance is enhanced when indicator is chosen based on the local conditions which lead to food insecurity. A third criterion is timeliness, which means the ability to produce required information using the indicators to be chosen for proper action by concerned bodies (Frankenbeger, 1992). On the other hand, Debebe (1995) indicates objective of the study and availability of the data as important criteria while choosing food security indicators.

Frankenberg (1992: 84) classifies food security indicators into two categories, namely; process and outcome indicators. The process indicators provide information on food supply and food access. One critical dimension of household food security is the availability of food in the area for the household to obtain. Therefore, food security indicators give information on the likelihood of shocks that adversely affect household food security (Frankenberger, 1992:85). This includes measurement of agricultural production, access to natural resources, institutional development and market infrastructure. Food accesses indicators are type of strategies household pursue in order to manage food insecurity problems. Therefore, there are different access indicators across regions, societies, gender, season and social status (Frankenberger, 1992; Debebe, 1995).

'Outcome' indicators are proxy indicators for measuring household food security. They regrouped into direct and indirect indicators. Direct indicators refer to indicators of direct food consumption whereas indirect are indicators like storage estimate, and nutritional status assessment (Frankenberger, 1992: 77). Hoddinott (2001) shows four methods of measuring household food security using outcome indicators, viz, individual calorie intake, household caloric consumption, dietary diversity, and indices of household coping strategies. Their application depends on the level of precision required and the amount of resources available (Debebe, 1995). Individual intake method is about collecting data on individual food intake in a household for a given period, usually 24 hrs.

The data include the amount and type of food consumed. If done properly, this method is the most appropriate one as it measures individual calorie intake and shows intra-household food security situation. But, the method requires skilled enumerators to collect data and at the same

time to account within person and within household day to day variation in nutrient intake (Debebe, 1995).

In case of household caloric consumption method, data is collected on the amount of food prepared and served for consumption over a given period of time usually 7 or 14 days. To this effect, questions are addressed to a member of a household who is knowledgeable person improvising information on food consumed. Amount and type of food purchased, prepared and then served are included and then cumulative estimate of calories consumed in a household is generated.

This method lessons the possibility of individual change in consumption behavior because of being observed by enumerators; it requires less skill of enumerators and time is required for data collection that is less than that of individual intake since household consumption method requires crude estimate of amount of calories consumed in the household. Dietary diversity is another method of measuring household food security. This is done through asking members of household about the types and frequency of food consumed by household within a given period.

The higher the type and the frequency of food consumed, the better the household in terms of food security. The method is simple, because it does not require quantitative data. Indices of household coping strategy are another method to measure household food security. An index is developed based on information generated through asking how household adapt to the presence or threat of food shortage. The higher the sum of coping strategy by household indicates the more food insecure a household. Among the four measurement methods that use outcome indicators, only the first two methods enable us to capture the calorie consumption of particular quantity.

For household caloric consumption method, gross calories is divided into the number of adult equivalent in household and then to number of days in the recall period result in a concise figure for average calories consumed per adult equivalent per day (Aschalew, 2006). This method requires less time and resource to generate data than that of individual method.

2.2.3 Global Food Security Situation

The number of undernourished people in the world remains unacceptably high at near one billion marks despite an expected decline in 2010 for the first time since 1995. This decline is largely

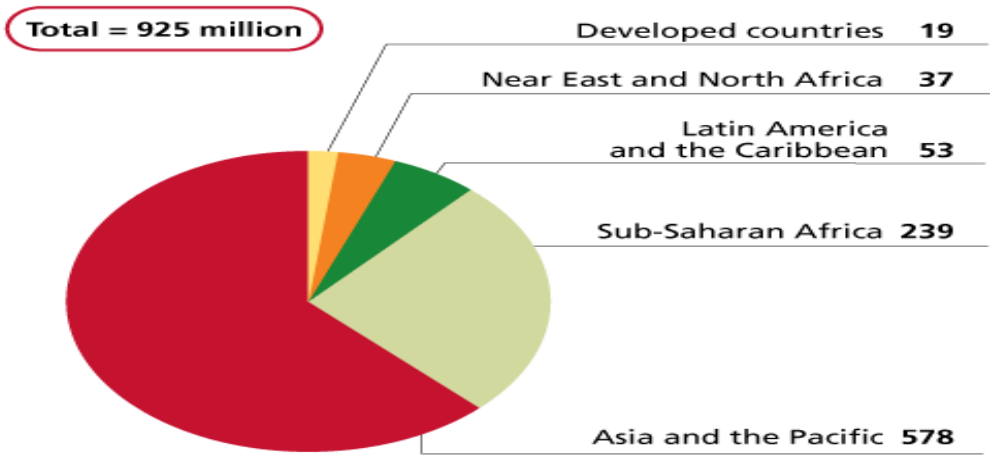
attributable to increased economic growth foreseen in 2010 particularly in developing countries and the fall in international food prices since 2008. However, a total of 925 million people are still estimated to be undernourished in 2010. Developing countries account for 98 percent of the world's undernourished people (FAO and WFP, 2010).

According to the World Bank, between 45 to 50 percent of the population in Sub-Saharan Africa live below the poverty line, making it the poorest region in the world. Food and Agricultural Organization (2010) reports show that approximately 33 per cent of the population in Sub-Saharan Africa is undernourished. There are 307 million hungry people in Africa, with most of these living in Sub-Saharan Africa (265 million). More than 40 percent of the population in the Horn of Africa (HoA) is undernourished and millions are food insecure (FAO,).

Worldwide, per capita 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 capita food availability are expected in all major regions. China and East Asia are projected to experience the largest increase in per capita food availability 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 (FAO, 2010).

By 2020, the number of food-insecure people in SSA is projected to exceed 500 million out of a total population of roughly 1 billion. In other words, without any significant increase in investment or change in historical trends of major indicators, more than half of the region's population consume less than the nutritional target. The region's food security position also deteriorates relative to the other regions. In 2020, the region accounts for only 27 percent of the population of the 70 countries, but it has about a 59-percent share of the total number of food-insecure people (FAO, 2010).

Figure 1 Hungry people in the world in millions (925 million in 2010)



Source: FAO. (2010).

2.2.4 Food Insecurity in the Horn of Africa

The Horn of Africa is one of the most food-insecure regions of the world. Out of a total population of almost 160 million, some 70 million people (around 45 percent) live in areas that have been subject to extreme food shortages and the risk of famine at least once every decade over the past 30 years (FA0, 2010) . In East Africa as a whole, 42 percent of the population is undernourished, and the figures for Somalia, Eritrea and Ethiopia are among the highest in the world. Chronic undernourishment is reflected in a very high incidence of stunting among children in low life expectancies. Child under nutrition, especially among those aged between six and 24 months is particularly damaging in that it results in a life-long reduction in physical and cognitive abilities.

More than 40 percent of the population in the Horn of Africa (HoA) is undernourished and millions are food insecure. Those suffering most from food insecurity are subsistence farmers, pastoralists and agro-pastoralists whose livelihoods largely depend on agriculture and animal production. Counting between 15 to 20 million people in the HoA, pastoralist communities live mainly in arid and semi-arid low lands and particularly suffer from droughts, as not only do they see their food consumption reduced, they also risk to lose their assets. With limited food and

water availability, animals produce less milk, which is more prone to diseases with their mortality incidence increases (FAO, 2010).

2.2.5. Food Security Situation in Ethiopia

Food insecurity and famine in Ethiopia is the result of erratic and low rainfall (Awulachew et al, 2005). Ethiopia faced three large-scale drought-induced food shortages and famines in recent history, i.e. in 1972/73, 1983/84, 2002/03, which costs many lives (Awulachew et al, 2005). In 2002/03 about 15 million people (over 20% of the population) received food aid. Population increase, deforestation and frequent land distribution has affected agricultural production in Ethiopia. This is reflected in a decrease in household production, grazing land and scarcity of manure. In 2006 for instance, about fifteen million people are facing food insecurity that is either chronic or transitory in nature. About five to six million people are chronically food insecure every year. There are people who do not have the capacity to produce or buy enough to meet their annual food needs even under normal weather and market conditions. The remaining ten million are vulnerable, with a weak resilience to any shock (FAO, 2006).

2.3. Irrigation, Household Income and Food Security

Irrigation with higher yields can allow countries to grow more of their own food and be less dependent upon imports, especially in view of the common occurrence of droughts in the region (Carter, 1991). Irrigation can raise the incomes of those farmers with access to irrigated land. The benefit is by reducing production risk and farm output diversification, thereby encouraging farmers to gain the benefits of greater specialization and commercialization at the same time enabling farmers to adapt timing of production to take into account market demand and higher prices (Hussain and Hanjra, 2004).

Since irrigation enables farmers to avoid adverse weather extremes and reduction of production of risk, it reduces the need to borrow and smoothen consumption, avoid costs of credit access, indebtedness or need to dispose of assets; and allow benefits from specialization or higher-value, facilitate development of multiple farm enterprise around livestock and crop (Smith, 1998).

Recently, the Ethiopian government, appreciating the contribution of irrigation to household income and food security, initiated irrigation development program for the period of 2005-2016

with a target of developing 276,612 hectare, which brings the total area under irrigation in the country to 471, 862 hectares where development of small-scale irrigation is given a priority. (MoWR, 2002).

2.4 Empirical Studies

There is a positive, albeit complex, link between water services for irrigation and other farm use, poverty alleviation and food security (FAO, 2002). The overall impact can be remarkable: in India, for example, in unirrigated districts 69% of people are poor, while in irrigated districts, only 26% are poor (World Bank, 1991). The availability of water confers opportunities to individuals and communities to boost food production, both in quantity and diversity to satisfy their own needs and also to generate income from surpluses.

Study conducted in Ethiopia by IWMI (2009) shows that irrigation generates an average income of approximately US$323/hectare under small householder-managed irrigation systems compared to an average income of US$147/ha for rainfed systems. This indicates that after accounting for annual investment replacement cost, the adjusted gross margin from irrigation is 219.7% higher than the gross margin from rainfed agriculture. According to IFPRI studies in India, the impact agriculture and food security additional irrigation investments on poverty reduction ranked third after rural roads, and agricultural research and extension. Additional government spending on irrigation had a significant impact on productivity growth (FAO, 2000).

Desta (2004) conducted impact assessment study on community managed irrigation schemes on productivity and household income in Weliso and Wenchi districts of Oromiya region through comparing irrigation users and non-users. The finding revealed that contribution of irrigated agriculture to income is about 70% in the highly irrigated villages as compared to 60% in two other low irrigated areas. At the same time, the absolute size of agricultural income is also the highest in highly irrigated village despite the lower land ownership size and cultivated holding by more than 30% over the low irrigated village. The share of agricultural income is also found to increase with the increase in irrigation intensity of the village. The highly irrigated village has higher per hectare agricultural income by over 50% over the low irrigated village.

Fuad (2002) in his study undertaken in east Shewa, Oromia region shows that cash crop economy with important cash flow offers a wide range of off-farm income possibilities as compared to

subsistence farming. About 45% of farmers involved in cash crop production are engaged in income generating off-farm activities while only 13% are from the non-cash crop producers.

The study carried by Shumba and Maposa (1996) revealed that, income generations and food security are major reasons for joining the scheme by beneficiaries. Employment creation was considered as a secondary objective. The irrigators meet their objectives by growing crops in the summer and vegetable in the winter. Notwithstanding the constraints, like unreliable water supply, limited cash for input purchase, poor roads and limited market outlets, the irrigators' objectives have been met to some extent. They reported having achieved improved food security, high incomes and increased employment opportunities in comparison to non-irrigators. The study also revealed that there was complementary among the objectives of food security, income generation and employment creation.

The study by IWMI (2009) depicted that irrigation generates an average income of approximately US$323/hectare(ha) under small householder-managed irrigation systems compared to an average income of US$147/ha for rainfed systems. This indicates that after accounting for annual investment replacement cost, the adjusted gross margin from irrigation is 219.7% higher than the gross margin from rainfed agriculture. The gross margin from medium- and large-scale systems was calculated to be US$400/ha and US$1,308/ha respectively (IWMI, 2009).

Roughly, 60 percent of the rice production and 40 percent of the wheat production in developing countries comes from irrigated land; thus, the success of irrigated agriculture and better irrigation access has large implications for poverty reduction and maintenance of food security in a nation. In china, Huang et al (2006) conducted a research to see irrigation and agricultural performance and its implication for poverty reduction. The result shows that there is a positive and a significant difference between yield of irrigated and non-irrigated plots. Wheat yield of irrigated plot are 70.9% higher than those of non-irrigated ones and at the same time irrigated maize yield are 16.4% higher. The findings further indicate larger difference in terms of revenue earned through irrigated and non-irrigated plots. Overall, revenue from irrigated plot is 79% higher than that of none irrigated plot.

Irrigation impact studies employ qualitative or quantitative approaches where "Before and after" intervention comparison; "With and without" comparison and average and Marginal Comparison

is used (Hussain, 2004). Food and Agriculture Organization (1996) suggests that in developing countries, irrigation can increase yields for most crops by 100 to 400%, while allowing farmers to reap the economic benefits of growing higher-value cash crops.

The total impact of irrigation can be best assessed by comparing two agro-environments, which are similar in all aspects, including endowment of resources, except in access to irrigation infrastructure. Bhatia (1991) reported the scale of irrigation impacts by comparing the performance of farm financial indicators across irrigated and non-irrigated regions in the state of Bihar, India. He showed the extent of variation in gross margin, net farm family income as well as the structures of farm expenditure between the irrigated and non-irrigated regions in Bihar. The level of additional net income or incremental benefits because of improved irrigation access was Rs 2,511 per hectare. This means that the farm income in irrigated areas was 77 percent higher than the income in non-irrigated regions of Bihar. The difference in farm income between these two regions has large implications for farm capital accumulation and wealth creation across the two regions.

2.5. Conceptual Framework

Irrigated agriculture plays a crucial role in the sustainable livelihoods of rural communities. Improvement in access to irrigation water serves as a powerful tool to diversify livelihoods and reduce vulnerability for small householder producers (Berhanu and Peden, 2003). There are five key dimensions how irrigated agriculture contributes to socioeconomic uplift of rural communities. These are production, income, consumption, employment, food security, and other social impacts contributing to overall improved welfare (Hussain and Hanjra, 2004).

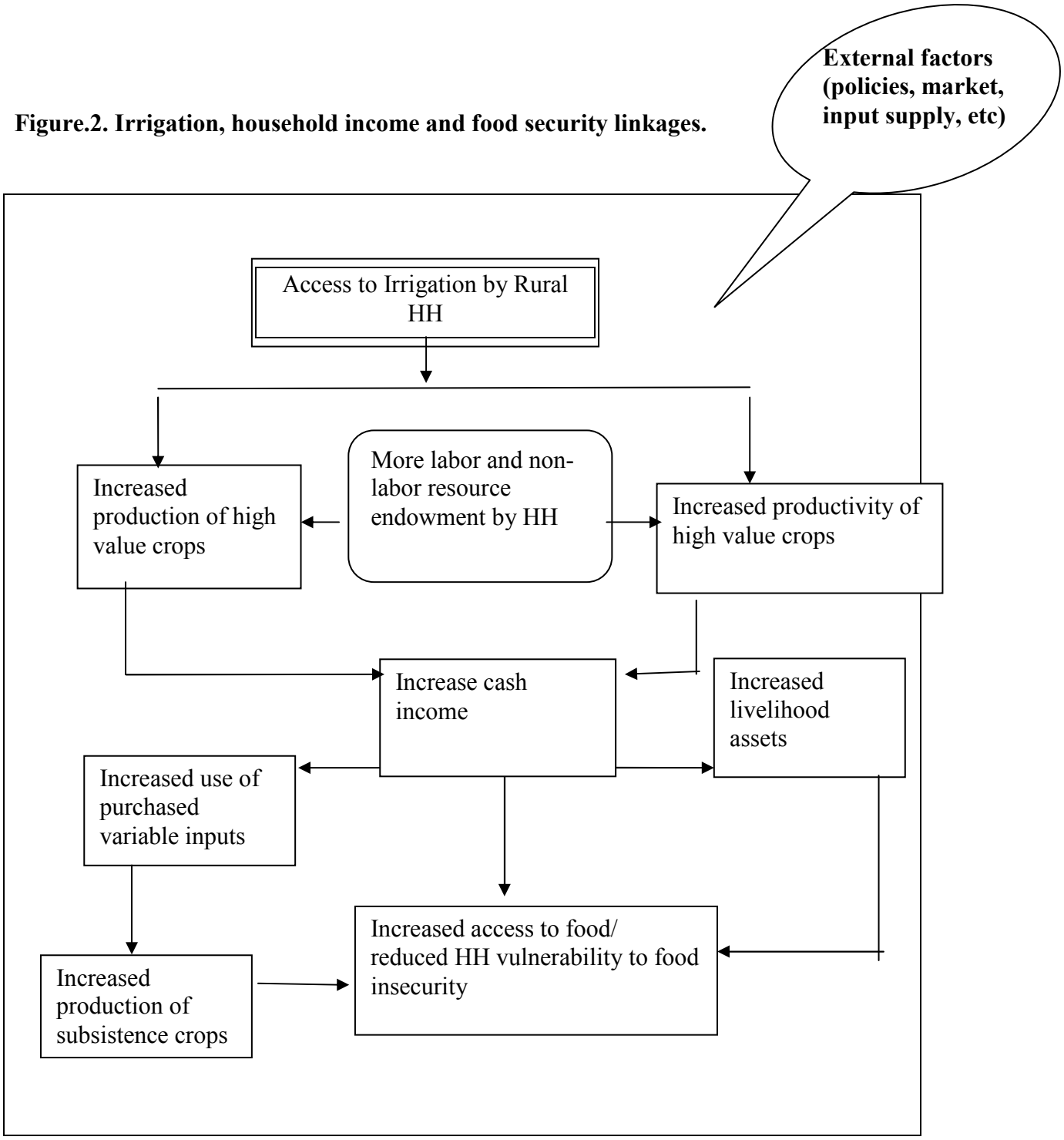
Hussain (2004a) noted that irrigation can benefit the poor through raising yields and production, lowering the risk of crop failure, and generating higher and year-round farm. It can enable small householders to adopt more diversified cropping patterns and to shift from low value subsistence production to high-value market-oriented production, which increase income of household. Besides, irrigation encourages farmers to produce more staple food crops (Ahmed and van Vuren, 1999).

Abebaw (2003) explains the importance of having sufficient income enabling an individual to purchase enough food for household. In many low-income developing countries, agriculture is

the main source of income and entitlement for rural families. However, it is impossible to generalize that only accessing irrigation water by rural poor solves the problems of food insecurity and income shortage. There are factors like markets, policies and other resources that affect directly or indirectly the food security and income situation of rural household. However, water is not the only a single element, but it plays important role in addressing the problems. Farm households who have access to irrigation able to increase cash crop production through year round cropping since water is available for crop to grow whenever needed; that means, risk of crop failure is reduced. At the same time, farmers would increase productivity of cash crops through use of complementary inputs (such as high yielding variety seeds, fertilizers, pesticides, etc.) since irrigation reduce risk of crop failure and therefore raise return to inputs.

The following simple conceptual framework (figure 2) is developed to show how access to irrigation increases household income and food security.

Figure.2. Irrigation, household income and food security linkages.



Source: Hussain, 2004).

The conceptual framework indicates that increased cash income through high value crop production through irrigation increase capacity of households to purchase food crops and also

reduce consumption shortfall, i.e. stability of income consumption. Still, expenditure pattern should be in favor of purchasing of food crops and at the same time there should be favorable relative price between high value crops and staple crops.

However, there are conditions which should be fulfilled, among others, availability of variable inputs on time, credit service to purchase inputs and provision of appropriate trainings. Higher production and productivity of high value crops lead farmers to fetch high income provided that favorable market prices and institutional arrangements are in place.

In the mean time, increased cash income enables farm households to purchase variable agricultural inputs for subsistence crop production which increase productivity and thereby increase availability of food for consumption at household level. Furthermore, farmers who use irrigation also able to increase their asset base through saving their income in form of livestock and other household assets and this lead households to be safe in case of shortage of food where farmers able to sale them and generated income to purchase food items.

There are strong direct and indirect linkages between irrigation and poverty (Hussain and Hanjira, 2004). Direct linkages operate through localized and household level effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Irrigation benefits the poor though higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment.

Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor. Since irrigation investments leads to production and supply shifts, indirect linkages operate through regional and national level and have a strong positive effect on the national economy. Past interventions in irrigated agriculture have yielded immense benefits, for example, cereal production in Asia has more than doubled between 1970 and 1995, from 300 million tons to 650 million tons (Hussain and Hanjra, 2004). Many SSA countries have recognized the contribution of irrigation to food production despite all the constraints identified (FAO, 2000). There are also examples of success in Africa. For example, in Zimbabwe, farmers could secure food production thanks to irrigation and the use of high yielding varieties and fertilizers (FAO, 2000).

In India, poverty head count ranges from 18 to 53% in irrigated and 21–66% in rainfed areas and poverty incidence is 20–30% lower in most irrigated areas compared to rainfed areas (Hussain and Hanjra, 2004). Studies using a dynamic concept of poverty show that the incidence of chronic poverty is 10% lower for irrigated areas in Sri Lanka(Pakistan) than adjoining rainfed areas (Hussain and Hanjra, 2004). These authors also identified five key interrelated linkages of how access to good irrigation water contributes to socio-economic uplift of rural communities and poverty alleviation. Accordingly, production, income and consumption, employment, food security, and other social impacts are contributing factors to overall improved welfare. Access to good irrigation facilities helps smallholders to increase their production and income, creates employment opportunities for the local people, increases the opportunity of smallholder to diversify their income base, and to decrease their vulnerability to drought due to short and erratic rain fall conditions.

Irrigation has a multi-facetted role in contributing towards food security, self-sufficiency, food production and exports. It encompasses a wide range of interventions that enhance productivity and result into profitability for the rural farming population and the nation as a whole. For the substantial areas managed by smallholder farmers through traditional irrigation systems or water harvesting, it assists both food production and cash crop improvements enabling farmers and surrounding communities to benefit both directly and indirectly from the crops produced.

In general, the conceptual framework shows how farm households are able to generate high-income through production of high value crops using irrigation. At the same time, the conceptual framework indicates how income to be generated increases household food security through production based entitlement (production of subsistent crops) and trade based entitlement given favorable internal and external factors in place.

Chapter Three

RESEARCH METHODOLOGY

This chapter reports on the research design and methodology that was employed in the research undertaking. The chapter has been organized into four major sections. The first section deals with description of the study area as well as the irrigation scheme. Attention has been given to description of the study area and irrigation scheme because the later is the subject of current investigation, while the former is equally important as food security analysis ought to be done within specific local context. Section two reports on research design and methodology employed and how the data set required for the research were generated. It includes type and source of data, sampling techniques and procedures, and data collection methods and instruments. The third section is concerned with how the data set was analyzed.

3.1Description of the Study Area

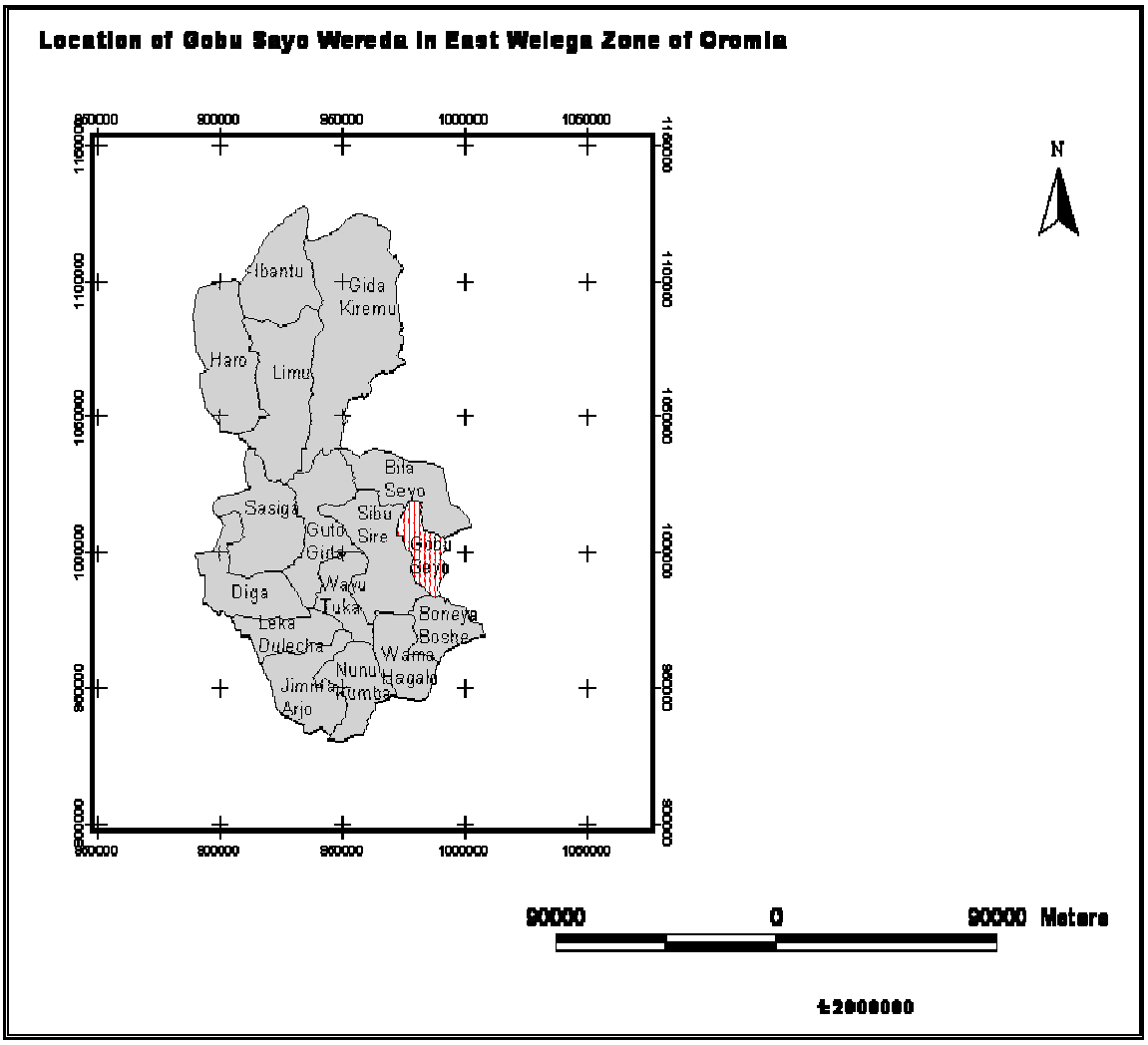
3.1.1Gobu Sayo Wereda

3.1.1. 1 Location

Gobu Sayo district is situated in East Wellega Zone of Oromia region 265 kms west of Addis Ababa. Its altitude is in the range of 1556-1680 meter above sea level. The capital town of Gobu Seyo (Ano) is located 65 K.M to East from Nekemte, the capital town of East Wellega Zone. The wereda consists of 9 Kebele Administrations (KAs).

The following map clearly indicates the location of Gobu Seyo Wereda in East Wellega Zone.

Figure 3 Map of Gobu Sayo Wereda



3.1.1.2. Area and Land Use

The total land area of the wereda is estimated to be about 33153 hectares of which 21640 hectares are cultivated, 1763 hectares are covered by forest, 1887 hectares are pasture land, 2019 and 1444 hectares are barren (degraded) and other unutilized land (GWADO, 2011

3.1.1.3. Population

The total population of the wereda is 45887 (49.44% male, 50.56 % female) in which 7241 are headed by male and 1055 are headed by female households. The family members in both households are 14,772 males and 22819 females.

3.1.1.4. Agro climate

The Agro climatic of the wereda are 80% weyena dega and 20% kola. The annual rainfall of the area ranges from maximum 1658 mm to minimum 830 mm where as the main rainfall season is from June to September and the dry season being from December to April. The annual maximum and minimum temperature ranges from 30^{O}C to 10^{O}C (Source, GWADO).

3.1.1.5. Agriculture

Agriculture is the main stay of the people in the study area and the wereda is high potential for crop and livestock production.

3.1.1.5.1. Crop production

The common crops produced by farm households in the area include maize, Finger milet, Teff and sorghum. Farmers also grow vegetables such as onion, tomato and pepper by using small irrigations. In the area, the major crop is maize, which is mainly known by high productivity, especially hybrid maize (BH660).

Table 1:Types of crops in Gobu Sayo Wereda

No	**Type of crop**	**Area in ha**	**Production in quintals**	Productivity Quintals//ha
1	Maize	7595	365496	48.1
2	Sorghum	1689.5	21680	12.83
3	Teff	7025	109240	15.55
4	Wheat	99	2067	20.9
5	Barley	38	674	17.3
6	Finger milet	1695	24887	14.7
7	Nuug	2012.5	14086	7
8	Faba bean	76	1168	15.4
9	Haricot bean	46	608	13.2
Total		**20276**	**539906**	**26.62**

Source; - GWADO, 2011

3.1.1.5.2. Livestock Production

Livestock production is one of the components of agricultural development activity in the study area. The livestock population of the wereda is shown in table 2. According to the information from GWADO, the livestock production challenges are lack of feed and prevalence of animal disease. The common and major animal diseases in the study area are Antrax, Black leg, Pasteurellosis, tuberculosis and brucellosis.

Table 2 : Livestock Population of the wereda

No	Types of livestock	Population in number
1	Oxen	197762
2	Cow	11699
3	Heifer	9903
4	Calves	7427
5	Mule	601
6	Horse	72
7	Donkey	3300
8	Sheep	5334
9	Goat	9283
10	Poultry	24954

Source; - GWADO (2011)

3.1.2. Details of the Irrigation Scheme

GambelaTere small scale irrigation scheme is constricted by the Regional Government of Oromia. The project was completed with 34 turnouts, division boxes and other structures were constructed along the main conveyance canal to bring additional 70 hectares of land under the command area of the scheme to benefit farmers whose land holdings fall on the left and right sides of the main conveyance canal (Farmers in Ongobo Dembi Kebele Administration). This increased the command area from 80 hectares to 150 hectares. In fact, the additional 70 hectare land brought under the command area was not considered in the initial design of the irrigation system.

The infrastructure was developed to benefit 225 households who have irrigable land in the command area and 1175 family members. The water source for Gambela Tere is Dokonu River. It was supposed to be perennial with a discharge of 0.25-0.587 m3 /sec at the time of design and construction.

A partially cemented main canal having a length of 7.23 kms conveys water to the command area of the irrigation scheme. Water supply to the farm units is rotational while the method of application is furrow. A night storage having a capacity of 8400 m3 was constructed to overcome water shortage through rotational distribution of water in day and night (See Figure 2).

Figure 4. Parts of the irrigation scheme

Photo by the Researcher, 2011

3.2 Sources of data

Quantitative and qualitative data were collected from primary and secondary sources. Primary data were collected from 150 sample households drawn from households residing in Ongobo Kebele Administration. The data collected include information of household characteristics (education, age, family size, sex,), household assets, household income, livestock holdings, land size, and household food security indicators.

Secondary data were collected from documents related to plot level agricultural inputs and outputs for 2009/2010 production season. In addition, relevant literature have been reviewed and utilized as data sources. Furthermore, documents compiled regarding water users association, Wereda Office of Agriculture and Rural Development reports and information from East Wellega Zone Agricultural Office were consulted. The information collected includes the detailed data with regard to agricultural and other development activities of the area.

3.3 Samples and Sampling Techniques

In this study, stratified random sampling method was employed to identify sample households for inclusion in the study. To this effect, list of the households residing in the area (612 households) was received from the Wereda Agricultural and Rural Development Office and list of participants of the irrigation scheme were obtained from the water users association. The households in the area were categorized into 2 strata, i.e., 225 irrigation users, and 377 non-users. From the total irrigation users, 75 (35%) households were included in the study taken by simple random sampling technique. For comparison purpose, 75 non-irrigation user participants were also included using simple random sampling technique.

3.4. Data collection instruments

3.4.1. Key Informants Interviews

Interview was one of the data collection instrument utilized in the course of the study. To this effect, household level survey was undertaken using key informants' semi-structured interview to generate information at household level. Prior to conducting the interview, pre-test of the interview items was scheduled with some farmers residing in the study area, which, in fact, were not included in the main study. Based on the responses obtained from the farmers, revision was

made to improve the readability and validity of the interview items. Accordingly, three items were rephrased for the sake of clarity and one item was fully discarded.

To conduct the interview, three enumerators were recruited based on their educational background, prior exposure to similar work and their proficiency in communicating through Afan Oromo. Training was given to enumerators on the content of the interview and the procedures to be followed in the process of conducting the interview. Key informant interviews have been made with development agents, WUA committee members, Gobuseyo wereda agricultural development experts, and elders who are knowledgeable about the study area

3.4.2. Focus Group Discussions

The second data collection instrument was focus group discussions. Focus group discussions were conducted with sample farmers from both the strata, i.e. irrigation users and non-irrigation users. Accordingly, focus group discussions were conducted with selected elder from community, WUA members, young and women irrigation users and non-users,

3. 4.3. Observation

Another data collection instrument employed for data collection was observation. The researcher was able to collect data from direct observation from the area. In the process of observation, checklist was prepared. Photographs was also taken by using digital camera

3.4.4. Questionnaire

Questionnaire was also utilized to collect appropriate and relevant information from household surveys. Semi-structured and Structured questionnaires were used for collecting quantitative and qualitative data from selected households. The household survey covered demographic characteristics, household socio-economic factors, plot characteristics, yields at plot level, and labor requirements.

3.5. Methods of Data Analysis

The data generated through questionnaire were coded and entered into SPSS version 17 software for statistical analysis. Descriptive statistics like mean, standard deviation, frequency distribution, and percentage were used to examine and understand the socio-economic situations of the sample

respondents by comparing irrigation users and non users. The data collected through observation, interview and focus group discussion were analyzed through narration. That is, the information collected via the aforementioned instruments were analyzed and interpreted by describing and narrating the information by the use of words.

To get the food security status of household, a modified form of a simple equation termed as Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and thenceforth used by different researchers in this field (Mesay, 2009) was used to calculate the per capita food available which is

GP + GB + FA + GG) - (HL+ GU + GS +GV) Where,
NGA= Net grain available/year/household
GP= Total grain produced/year/household
GB= Total grain bought/year/household
FA= Quantity of food aid obtained/year/household
GG= Total grain obtained through gift or remittance/year/household
HL= Post harvest losses/year
GU=Quantity of grain reserved for seed/year/household
GS=Amount of grain sold/year/household
GV=Grain given to others within a year (Mesay, 2009).

The net grain available by sample households' calorie content was computed using calorie conversion table of (EHNRI, 1968) (see Table2 in apendix). Household members were also converted to their adult equivalent (Table3in appendix). Then, the amount of total calories available by each sample household was computed and divided by 365 days to get per day calorie available for household. This figure was divided to the Adult Equivalent (AE) of respective households, which finally was given the amount of calorie available per AE for each sampled household. Thus, those households greater than the minimum amount of calorie required (2100 kcal) was put under food secured otherwise not food secured (Hoddinott, 2001). The situation of household food security within irrigation users and non-users was also seen independently.

In order to calculate rate of return to land management of rainfed and irrigated vegetable crops grown by irrigation users 2009/2010 production season, the cost of production and benefit were surveyed and calculated. net return of per hectare is identified. The calculation is as follows:

Total cost = Labor cost (birr/ha) + Seed, fertilizers and pesticide Cost (Birr/ha) +oxen cost

Total income (Birr/ha) = Net production (qt/ha) x Market price (birr/kg)

Net income (Birr/ha) = Total income (Birr/ha) – Total cost (Birr/ha)

Chapter Four

RESULTS AND DISCUSSION

This chapter reports the findings of the study. The chapter is divided into five main sections. The first section presents descriptive statistics on variables relevant to the analysis such as demographic, socio-economic characteristics and agricultural activities of sample households. In the second section, results of the assessment of food security status of households are presented and discussed. This is then followed by the estimation result using the partial budgeting technique of monitory benefit of irrigated crop production in the third section. The fourth and fifth finally, a brief summary is made based on findings on how irrigated agriculture contributed to the households' income and food security

4.1 Household Characteristics

4.1.1 Age

Farmers acquire experience and knowledge through devoting their time to farming activities. Therefore, higher age means better farming experience and accordingly better condition in terms of food security enables them become more risk avert.

Table3: Age distribution of sample household heads

Age (yrs)	User n=75		Non user n=75	
	N	%	n	%
18-25	4	5.3	4	5.3
26-40	38	50.7	33	44
41-55	24	32	33	44
>55	9	12	5	6.7
Total	75	100	75	100

Source: Own Survey, 2011

Table 3 indicates the mean age of the irrigation users (beneficiary of the irrigation scheme) and nonusers, which were 40.99 and 41.48 with standard deviation of 10.79 and 9.69 respectively.

The majority of household heads were found within age range of 26-55, which accounts more than 85 % where users and nonusers accounted almost equal proportion.

4.1.2. Sex Composition of Household Heads

In most cases, male-headed households have more access to agricultural technologies, labor power, and farm land as compared to female-headed households. As the result, they have the opportunity to produce more and derive higher income. Therefore, they are less likely to become food insecure than female headed households.

Table4: Sex composition of sample households

	User n=75		None User n=75		Total n=150	
	N	**%**	**n**	**%**	**n**	**%**
M	60	80	59	78.7	119	79.3
F	15	20	16	21.3	31	20.7

Source: Own Survey, 2011

As table 4 shows, out of the 150 sample households, more than 79 percent were male-headed and the rest of them were female headed. The proportion of male-headed households in both user and non-users groups were more or less similar (80% and78.7%) respectively.

4.1.3. Education of Household Heads

Education is an important characteristic that determines the farmer's ability to communicate, acquire information and to adopt new technologies. Among the sample farmers, the majority (64.7) were illiterate, while only about11.3% could read and write. The rest attended formal elementary, junior and secondary school as can be seen from Table 5.

Table5: Education Status of Sample Household Heads

Education	User n=75		Non user n=75		Total=150	
	N	%	n	%	n	%
Illiterate	46	61.3	48	62.7	92	64.7
Read and write	8	10.7	9	-	17	11.3
1- 4 grade	7	9.3	7	14.7	14	12.0
5-8 grade	10	13.3	8	14.7	18	14.0
9-12 grade	4	5.3	3	6.7	7	6.0

Source: Own Survey, 2011

The data in Table 5 indicate that majority of the sample household heads are illiterate with the implication that majority of the respondents may not have appropriate ability to adapt the required communication, acquire relevant information and utilize new technologies in their livelihood.

4.1.4. Dependency Ratio and Family Size

Household with high dependency ratio faces shortage of labor to undertake activities that bring benefit to household, which implies that active members of the household have to support themselves and other members of the household economically. Household members aged below 15 and above 64 are considered to be dependents. Dividing the sum of household members whose age is between 15 – 64 results into dependency ratio, i.e., number of household aged 1-14 plus the number of household aged 65 and above divided by the number of household aged 15-64. This can be observed from Table 6.

Table 6: Dependency Ratio of Sample Households

Dependency ratio (No)	Users(n=75)		Non-users (n=75)		Total (n=150)	
	n	%	n	%	n	%
0 – 1.00	39	52.	38	50.7	77	51.3
1.01 – 2.00	29	38.7	35	46.7	64	42.7
2.01- 4	7	9.3	2	2.7	8	6
Mean (No)	1.22		1.25		1.23	
SD	0.7		0.55		.63	

Source: Own Survey ,2011

Accordingly, the distribution of dependency ratio for sample households shows that about 52 percent of sample households' dependency ratio falls within 0-1 Table 6) indicating that active member of a household is expected to support at least one member of the family economically. The result is almost similar for irrigation users (about 52%) and non-users (about 51.3%), i.e. the dependency ratio range is 0-1 for both household types. The mean dependency ratio for irrigation users and non-users was found to be 1.22 and 1.25 with standard deviation of 0 .70 and 0 .55 respectively. The overall mean of dependency ratio of sample households was 1.23. The result shows that there is no statistically significant difference in mean value dependency ratio between the two groups.

4.1.5 Family Size of Sampled Household heads

The mean family size of irrigation user is 5.91 and none user is 6.1 and thus there is no significant difference between family size as indicated in Table 7.

Table 7: Households Family Size and Age Distribution

Total household members	User n=75		None user n=75		Total 150	
	N	Mean	N	Mean	N	Mean
Household size (Male , female)	233(M) 210(F)	5.91	244(M) 213(F)	6.1	477(M) 423(F)	6
Household age <12 years	142	6.3	179	6.9	321	6.6
Age 12-17 years	92	14.3	104	14.3	196	14.3
Age 18-60 years	207	31.3	180	31.6	387	31.4
>60	3	65.7	3	71.3	6	68.5

Source: Own Survey, 2011

4.2 Household Resource Endowment

4.2.1 Labor availability

Family labor is the main source of work force for the farming community in the study area. The total labor available to each sample household was converted to man equivalent to examine

differences in household labor availability (see appendix in table 4 about conversion factor of Man equivalent).. As shown in Table 8, the mean available labor in man equivalent was 2.14 with the minimum and maximum being1 and 5.1 respectively.

Table 8: Labor availability of sampled household

Group of households	Minimum	Maximum	Mean	Std. Deviation
User	1.00	5.10	2.35	.75
Non-users	1.00	4.60	1.94	.75
Total	1.00	5.10	2.14	.78

Source: Own Survey 2011

According to these data, the labor availability between irrigation users and non-users differ in that users had large labor endowment (2.35 Man - Equivalent) than non-users (1.94 Man equivalents) This indicates that there is significant difference between the two groups in terms of availability of labor because of hired lbour in irrigation development activities by irrigation users .

Labor availability is very important particularly for those who participate in irrigation farming. Irrigation farming requires high labor as compared to rainfed agriculture due to intensify production system in irrigation development.. Sample farmers were asked whether the labor in the household was enough for agricultural activities during the study period and most of them (70% where is this data) responded that it is not enough. However, as a strategy to address the labor shortage, irrigation users (59%) reported the use of hired labor as a means of tackling the problem than non-users (12.3%). Instead, majority of the non-users (64.6%) mentioned that they use shared labor as a means to address labor shortage.

This is due to the capacity that irrigation users have to hire labor from outside as a result of the income generated from irrigation activities. The finding strengthens the existing literature in labor utilization schemes. For instance, Hussain (2004a) confirmed that labor employment per hectare and wage rates are higher in irrigated setting than in non irrigated setting where irrigation users serve as employers of additional labor of the adjoin non irrigated area.

4.2.2. Farm Land Holding

The livelihood of the farming communities in the study area primarily depends on agriculture where crop production plays important role. Farmers need to have enough land for cultivations as to produce different crops. Result from the study shows (table 9) that nearly 72.0% of the respondents have farm land size of 1.5 hectare or less while 22.7% of the respondents own land within 1.51-3 hectare limits. Households who own land size of more than 3 hectare accounted for 5.3%. Irrigation users have mean land size of 1.3 hectare where as the non-users have 1.36 hectare.

Table 9: Cultivated lands by sample households

Land size (ha)	User n=75		Non user n=75	
	n	%	N	%
< 1.50	55	73.3	54	72.0
1.51 – 3	16	21.3	17	22.7
3+	4	5.3	4	5.3
Mean	1.30		1.36	

Source: Own Survey, 2011

According to the FGD irrigation users start to rent the farm land by the income they earn from irrigation development.

4.2.3. Livestock Ownership

The farmers in the study area are practicing mixed farming system where livestock production is an integral part of the system. Livestock benefits in different ways, namely, as a source of power for ploughing, source of cash income, source of nutrition and means of transport. In view of this, an inventory of livestock holding of the sample households of users and non-users of irrigation was undertaken. In order to make comparison of the livestock size between the two groups, the herd size was converted into Tropical Livestock Unit (TLU) based on Storck et al, (1991). Table 10 shows livestock ownership by irrigation users is almost more than double than that of non-users.

Table 10: Livestock ownership by sample households (TLU)

Livestock TLU)	User n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
<=3	12	32.0	25	30.7	37	24.7
3.o1-8	27	36.0	39	52.0	66	44.0
8.01-12	24	16.0	11	17.3	35	23.3
>12	12				12	8
Mean	6.76		3.92		3.03	
SD	1.05		0.68		0.93	

Source: Own Survey, 2011

As can be seen from the Table, the number of farmers who own more than 8 TLU was 36 for users and only11 for non-users.

The mean livestock ownership of irrigation users before participation in irrigation indicated that 2.5 TLU while after participation it was 6.76 TLU. One of the important means that farmers in the study area use to save their income was through purchase of livestock. From this study, it is possible to see that irrigation users are in a better position in terms of livestock ownership that goes in line with the existing literature (Haspin et al., 2001; Fuad, 2002) confirming that income generated from high value crop production by using irrigation. At the same time, farmers who engage in irrigation development provide cheaper and more secure fodder for their livestock and therefore they're encouraged to rear livestock than non-participants. According to the FGD, it was also proved that the income they obtained from irrigation development helps farmers to use better veterinary service for the health of their livestock. More improved animal feed utilization by irrigation users was also observed by the researcher during the field visit.

4.2.4. Oxen Ownership

Oxen play an important role for farming community in the study area as farmers in the area solely depend on traditional farming method. Hence, oxen are an important factor of production as it is the primary source of power for land cultivation. To see the distribution of oxen ownership between the two groups, inventory data was generated on number of oxen owned by sample

households. Table 11 shows that 13.3% of the sample households were without oxen and about 27.3% of them owned only 1 ox, 37.4% owned 2 and 22 % owned 3 or more.

Table11: Oxen ownership by sample households

Oxen (No)	User n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
0	11	14.7	9	12.0	20	13.3
1	13	17.3	28	37.3	41	27.3
2	28	37.3	28	37.4	56	37.4
3-5	17	22.7	10	13.3	27	18.0
>=6	6	8.0	-	-	6	4.0
Mean	2.2		1.5		1.9	

Source: Own Survey, 2011

The mean size of oxen ownership between irrigation users is larger (2.2) than that of non-users (1.5) and the overall mean being 1.7. There is significant difference in oxen ownership between the means of irrigation users and non-users before and after irrigation participation comparison for users also showed that there is an increase in mean of oxen ownership from1.82 TLU to 2.2 TLU.

4.2.5. Household Asset

The introduction of irrigation scheme has increased the asset holding of households. Households also reported that a significant increase in investment in livestock and said that they are better able to meet the costs of living since the introduction of irrigation. It therefore appears that irrigation can make a significant contribution to increasing household resilience and buffering livelihoods against shocks and stresses.

The reported value of assets owned has also increased significantly from 8634.5 birr to 36482.76 with an increase of over 422% (Table 13). Reported value of all categories of assets has increased apart from valuables (radio, watch, etc). Beneficiaries reported significant increases in the value of their farm tools, household furniture and equipment, house and other physical assets that has been observed through converting their asset to the current price. During irrigation users' focus

group discussion, participants confirm that their income had increased four-fold following the introduction of irrigation.

Irrigation development should enable households to accumulate wealth and therefore higher asset for those who have participated with impact on household food security. Farmers use income of agricultural activities to build asset in a form of construction of house, purchase of agricultural equipment and household goods, etc. Different literatures indicate that farmers who engage in cash crop production using irrigation generate income and accordingly build household assets. The household asset values included in the study were house, agricultural equipments, nonagricultural equipments, and household goods.

Table12: Current Asset Value of Sample Households

Asset value (Birr)	Asset value					
	User n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
<=1000	3	4	4	5.3	7	4.7
1001-3000	14	18.7	20	26.7	34	22.7
3001-7000	10	13.3	28	37.3	38	25.3
7001-30000	25	33.3	16	21.3	41	27.3
>30000	23	30.7	7	9.4	30	20
Mean	36482.76		14613.92		25531.67	

Source: Own survey (2011).

As Table 12 indicates, the mean asset possession of irrigation users and non-users were Birr 36482.76 and 14613.92 respectively. This indicates that irrigation users had more two and half fold asset values than that of nonusers.

About 30.7% of irrigation users (fall under asset value category of Birr>30000) while for non-users about only 9.4 % only fall in this category. The asset value of irrigation user after irrigation is almost four fold than before irrigation.

Table 13: Asset value changes of irrigation users before and after irrigation

Mean Irrigation in asset user	Asset Value in (Birr)		
	Before	**After**	**Change%**
	8634.5	36482.76	422

Source: Own Survey (2011)

The qualitative data obtained from household survey show that majority of the irrigation users save their money by buying assets and saving in Banks.

4.3. Inputs and Other Services

4.3.1 Extension Service

Availability of extension service to farmers plays an important role in terms of creating knowledge and skill in using improved agricultural inputs. The government is the only agency which provides extension service in the study area. During the study time, there were three development agents assigned by government to provide extension services to the farmers in the area. Frequency of extension service was measured and the results are indicated in table 15. Accordingly, about 35.4% of households received extension advice on fortnightly basis, whereas 37.3 % received on weekly basis and 27.3 % received on monthly and more than monthly basis.

The frequency in case of irrigation users and non-users differs. One of the areas where extension service was given was in the area of irrigation development where irrigation users benefit out of it.

Table 14: Extension Service Obtained by Sample Household Head

Contact	**User n=75**		**Non user n=75**		**Total=150**	
	n	**%**	**n**	**%**	**n**	**%**
Once a week	45	60	11	14.7	56	37.3
Every 15 days	20	26.7	33	44	53	35.4
once a month	10	13.3	11	14.7	21	14
Oncein3 month			17	22.7	17	11.3
Once in a season			3	4	3	2

Source: own survey, 2011

As can be depicted from Table 14, the highest irrigation users received is four fold than the non-users in a week. The reason why the extension service concentrated on irrigation area is due to the crop intensity of irrigation throughout the year. Irrigation users start to produce more than twice per year on the same land. The irrigation development need more skill and need to use improved inputs, thus, the user need frequently to contact with the DAs.

4. 3.2 Credit service

Access by farmers for agricultural credit service makes them produce more by the use of credit services to purchase modern agricultural inputs like fertilizers, chemical and improved seeds. However, 60.7% of the sample households (Table 15) were not participating in credit service in the study area during the study period. The majority of the respondents indicated that lack of capacity to payback credit in case of crops failure was one of the main problems.

Irrigated agriculture is intensive that requires improved agricultural inputs than rainfed, which in turn demand availability of cash in the form of credit or otherwise to purchase the required inputs. The study result showed that, participation of farmers in credit differs between irrigation users and non-users. About 76% of irrigation users participated in credit service whereas it was only 26.7% for non-users.

Table 15: Participation of credit

Credit	User n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
Yes	57	76	20	26.7	59	39.3
No	18	24	55	73.3	91	60.7

Source: Own Survey, 2011

As can be seen from Table 15, the survey result confirmed that there were more number of credit users in irrigation users group than non- users group. Similarly, responses from qualitative response of the respondents proved that irrigation users' participation in credit after implementation of irrigation was increased.

The increased involvement of irrigation users in credit service may be because of their confidence to payback credit as agricultural production through irrigation has less risk of crop failure. Besides, irrigation allows more than one time production per year that enables farmers to produce more and brings high return to agricultural inputs, which eventually build capacity of the farmers to payback credit.

4 3.3 Fertilizer Use

Use of fertilizer for crop production plays an important role for production and productivity. In the study area, use of fertilizer is very important input for production of crop. Irrigation by its very nature demands the use of more improved agricultural inputs like fertilizer in order to produce high value crops like vegetables. In most cases, availability of irrigation encourages farmers to use fertilizer for production of high value crops, which fetches high prices and cover incurred costs (Hazell and Ramasamy, 1991).

Table16: Fertilizer Use in kg /ha by Sample Household Heads

Fertilizer(Kg/ha)	User n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
0-0.49	20	26.7	36	48.0	56	37.3
0.5-149	6	8.0	10	13.3	16	10.7
151-300	20	26.7	27	36.0	67	44.7
>300	29	38.6	2	2.7	11	7.3
Mean(Kg/ha)	292		163		228	

Source: Own Survey, 2011

As can be observed from Table 16, analysis of fertilizer use by the two groups indicate that the mean amount of fertilizer use per household was 292 for irrigation users and 163 for non-users (mean difference was 129 fertilizer **kg** /ha for users).

Regarding application of fertilizer for crop production from the two groups' perspective, it has been indicated in Table 17 that about 77.3% irrigation users and 53.3% non-users apply fertilizer for crop production.

Table17: Participation in Fertilizer Use by Sample Household Heads

	n=75		Non user n=75		Total=150	
	n	%	n	%	n	%
Yes	58	77.3	40	53.3	98	65.3
No	17	22.7	35	46.7	52	34.7
Total	75	100	75	100	150	100

Source: Own Survey, 2011

The implication of this find indicate that crop intensification is better in irrigation farming than rainfed farming since the return of irrigation farm is better than rainfed farming.

4.4 Benefits of Irrigation for intensification of production

Among the indicators frequently used to assess irrigation benefits is the rate of use of land equipped for irrigation which is that part of the equipped area actually used for production at least once a year, and the cropping intensity, which is the ratio between irrigated crop areas (where double or triple cropping areas are counted twice or three times respectively) and the physical areas equipped for irrigation (FAO, 1997)

Irrigation has a dual effect in terms of enhancing productivity and reducing food insecurity in the study area. Farmers through increased input use and adoption of more intensive cultivation practice intensify their production by irrigation. In the study area the most frequently cultivated crops are maize, onion, tomato and pepper. As indicated in Table 18, the yield difference between irrigated and rainfed agriculture were maize 38, onion 55, tomato 88 and pepper is 60 quintals per hectare. This may be due to the possibility of controlling water application according to the water requirement of crop.

Table18: Comparison of Average yield quintal/ha of crops and vegetables cultivated under rainfed and irrigated cultivation

Type of crop	Irrigated	Rainfed	Difference
Maize	78	40	38
Onion	120	65	55
Tomato	250	162	88
Peper	140	80	60

Source: Own Survey, 2011

The intensity of irrigated farm is not only by yield per hectare but the frequency of cropping on the same land is different with the rainfed farm. Almost all of the irrigation users tend to produce twice on the same land per year and 20% of the irrigation users could also produce three times on their irrigated land per year.

The effectiveness of fertilizer and improved seed variety is also effective on irrigated farm. Irrigation increases both crop yields and application of mineral fertilizers, which in turn contributes to higher land productivity and improved incomes of farm households. Irrigation further enables farmers to cultivate non-traditional high value crops, such as tomato, onion, green pepper and leafy vegetables.

Farmers and extension workers reported that the productivity of irrigation land is almost double of what could be harvested from the ranifed, if it is cultivated using improved seeds and chemical fertilizers. This is attributed to the fact that in rainfed agriculture, water is a limiting factor and there have been better farm management practices of irrigation farming. Although irrigation helps to increase agricultural production, high return depends on other factors such as adequate usage of fertilizer and labor. Irrigation promotes the use of other inputs through supply of moisture at time of unreliable rainfall. Accordingly, the survey result revealed that the mean per household use of fertilizer was 292 Kg and 163 Kg from irrigation users and none users. One of the major advantages of irrigation is the possibility of adopting high value crops (vegetable and fruits), which needs year round water supply. These types of crops are in fact, reliable source of household income.

4.5 Benefit of Irrigation for Production Diversification

Access to irrigation has facilitated interest in agricultural diversification stemmed to reduce individual farm income risk and food supply risk. Agricultural diversification can reduce the instability of income. Multiple uses of irrigation are related to linkage effects and livelihood diversification (See Figure 5). Vegetables, fruits, coffee and beekeeping were observed during household survey in the study area. According to the survey result, about 86% of irrigation users tend to produce more additional new crop due to the introduction of irrigation. The crops are tomato, potato, onion cabbage, carrot, and other horticultural and fruits crops.

Table 19: New types of crops introduced due to irrigation

Number of crops	n=75	%
4	10	13.3
3	25	33.3
2	28	37.4
1	12	16

Source: Own Survey, 2011

This proves that non-irrigation users have never been engaged in the introduction of new types of crops, especially in the dry season.

Figure 5.1 Diversified Agricultural Developments by Irrigation Users

Photo by Researcher, 2011

In the study area, farmers reported their substantial benefits from irrigation. They reported an increase in income (gaining up to 400%) by diversifying their production, which in turn enabled them to build up their assets, buy more food and non-food household items, educate their children, and reinvest in further increasing their production by buying farm inputs or livestock.

Households typically experienced a direct increase in income following adoption of irrigation. Almost 95% of households surveyed reported that their income had increased. This was achieved, may be due to diversification to new crops, principally new high-value vegetable varieties. They started to produce twice a year instead of once.

Literature proves that there are strong direct and indirect linkages between irrigation and poverty. Direct linkages operate via localized and household-level effects, and indirect linkages operate via aggregate or national-level impacts. Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and nonfarm employments. Irrigation enables smallholders to adopt more diversified cropping patterns and to switch from low-value subsistence production to high-value, market-oriented production (Husen, 2004).

In relation to this, Ato Tamiru 25 years old is one of participants whom the researcher has visited his house during field study. Ato Tamiru build comfortable house as showed on the photograph.

Figure 5.2 Diversified Activities by Irrigation Users

Photo by Researcher, 2011

He produced tomato and onion last year which he sold at birr 28,450.00. He helps his brothers and sisters, as well as his family. He starts to transport the product directly to vegetable market in Addis Ababa with the products he collects from his friends. Last year, he was elected as a model farmer and obtained prize at regional and federal level. According to his plan, he wants to buy farm machine like Tractor to invest more in the sector and to rent the farm machine. During the visit, the researcher observed that Ato Tamiru diversified his production due to irrigation. For example, he has developed the interest of beekeeping, which uses, the flower of fruit trees and horticulture by irrigation during the dry season, in fact, without any additional expense. His homestead is surrounded by coffee, mango and other fruit trees. This and other survey data prove that using irrigation facilitates diversification of production, sometimes without any additional expense.

Furthermore, focus group discussion participants of irrigation users reported that annual cash income from farm activities has increased quite substantially from different sources, have increased to varying degrees since the introduction of irrigation scheme. Ato Mola, who is one of the discussants, is 55 years old who produces tomato on 1 hectare of his plot. He also plant fruit trees and he benefited from the production of fruits that enabled him to earn substantial amount of money leading him to built house at Anno town, capital city of the Wereda. He also bought a grinding machine, which he is benefiting from the machine. On his irrigation plot, he even started to employ skilled daily laborer who come from other areas. He is now well experienced and starts to use modern tomato production system. Furthermore, Ato Mola has sufficient amount of grain he already produced, specially maize and vegetable that enabled him to diversify more of his production supported by modern approaches. In fact, he fears the problem he sometimes faces due to the instability of market, which sometimes may not be attractive as needed.

Figure 6. Ato Mola and his irrigated plot and Grain store

Photo by Researcher, 2011

4.6. Contribution of Irrigation to the Household Income

In this section, discussion about contribution of irrigation to the households' income income generation from livestock and rainfed agriculture by the two sample groups has been presented. Crop and livestock income play important role for households in the study area. According to the report from the sample population, irrigation users have generated mean income of 7822.4 Birr from their irrigated plots.

Table 20: Annual incomes per household Generated by Sample Households from the Irrigated Crops Income (Birr)/household/year

Income (Birr)/household/year	n=75 only users	%
1000-2500	22	29.3
2501-4500	4	5.3
4501- 10000	31	41.4
>10000-	18	24
Total	75	100
Mean	7822.4	

Source: Own survey

In Table 21, sample households' income from rainfed crop production is indicated. From the Table 21, it is possible to note that the mean of the sample households' income was Birr 9534.07 and the mean income of irrigation users from rainfed crop was birr 10069.8and birr 8533.8 for non-users. In terms of mean income, the study revealed that irrigation users were in a better position in income generation that shows significant difference between the two groups in their mean income. This may be due to the increased income from irrigation that encouraged irrigation users to produce more staple food crops (Ahmed and von Vuren, 1999) as indicated in Table 21.

Table 21: Income Generated by Sample Households from Rainfed Crops Income Birr)/household/year

Birr	User n=75		Non User n=75		Total n=150	
	N	%	n	%	n	%
1000-2500	16	21.4	20	26.7	36	24
2501-4500	9	12	20	26.7	29	19.3
4501- 10000	25	33.3	24	32	49	32.7
>10000	25	33.3	11	14,6	27	18
Mean	10534.34		8533.8	-	9534.07	
Std. Deviation	10069.8		8896	-	9534.07	-
t-value	7.8		8.3	-	9.4	-

Source: own survey, 2011

Farmers also generate income from livestock in different forms. As shown in Table 22, income from livestock for sampled households differs between irrigation users and non-users. From the irrigation users' perspectives, the mean income was Birr 1562.83/year while it was Birr 611.43 for non-users (Table 22). There is difference between the mean incomes of the two groups with irrigation users having higher livestock income than non-users. This may be due to increased number of livestock due to income from irrigation and at the same time availability of fodder for livestock production (Haspin et al 2001; Fuad, 2002), which may have contributed for increased income from livestock.

According to FGD, livestock number has increased due to the introduction of irrigation and increased income from irrigation to buy more animals. Increase in animal feed from crop residue due to the grass around canals and better veterinary service attainments. Key informants also said that with the introduction of irrigation, there emerged changes in the way they use to get water for their livestock. These changes are advantageous because it has brought about easy access to water for their livestock just from the nearby reservoir.

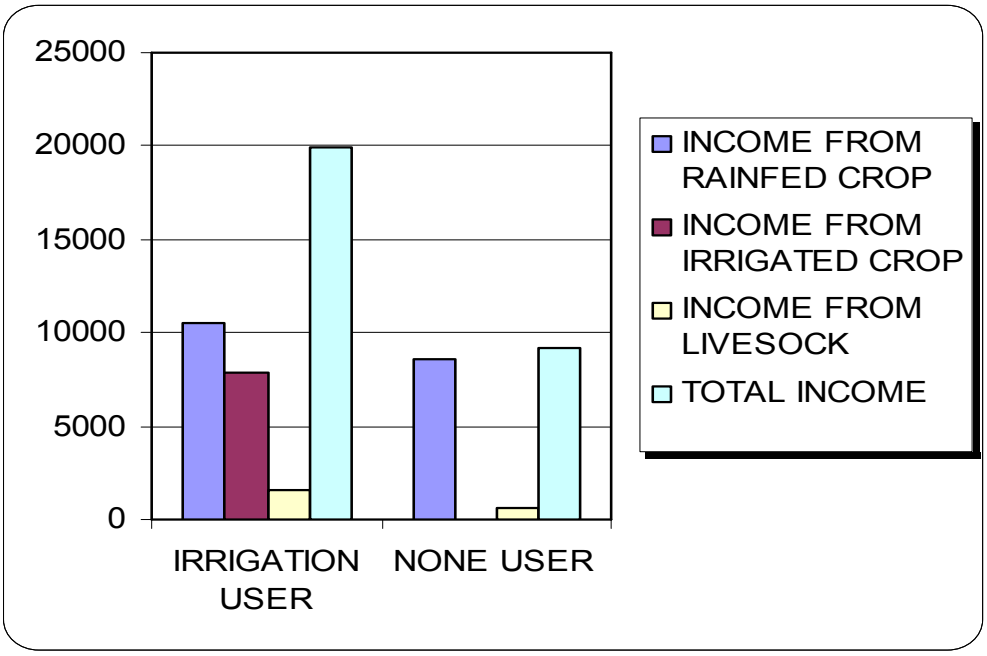
Table 22: Income Generated by Sample Household from Livestock and Livestock Products

Birr)/household/year	User n=75		Non User n=75		Total n=150	
	n	%	n	%	n	%
0-50	23	30.7	30	40.0	53	35.3
51 -1500	24	32.0	34	45.3	25	16.7
1501-3500	18	24.0	9	12.0	60	40
3501-8542	10	13.3	2	2.7	12	8.0
Total	75	100.0	75	100.0	150	100
Mean	1562.83		611.43		1087.13	

Source: Own Survey, 2011

The total mean income of irrigation users and non-users, as indicated in Figure 8, the total mean income of users is almost double than non-users. From this discussion, irrigation users can get more income from vegetables through irrigation on the same land; they can produce cereals, which is also in a better position due to better fertilizer and use of improved inputs. The income from livestock is better for irrigation users than non-users and the mean total income of irrigation users per member is more than double than non-users.

Figure: - 7 Total Mean Income of Sampled Household



4. 7. Comparison of irrigated and non-irrigated crops Income

For the analysis, data collected from irrigation users were considered since the objective of the analysis is to measure contribution of income from irrigated crops to overall households' crop income.

The study has presented evidence to show that irrigation users produce more food than non-users. The output of irrigation users is greater than non-users output from dry land production; irrigated lands were highest than non-irrigated reference areas of the net productivity. The output values between irrigated and non irrigated lands varied. From the data collected, it is possible to note that in the study area, sample households were primarily engaged in production of maize, and *Teff* under rainfed agriculture through allocating large proportion of land for the production of these crops.

Therefore, these crops were considered for estimation of net return. In the same manner, the data collected shows that vegetables grown during the study period (production season) by the irrigation users were onion and tomato. Therefore, onion and tomato were the crops grown under irrigation and included in this analysis.

For each crop under rainfed and irrigated land, farming data were collected on the size of land planted, quantity and prices of inputs used, which include seed, fertilizer, chemical (pesticides and herbicides), labor and oxen rental cost. Table 23 indicates crop based information on input costs and returns on the basis of these data, net return from rainfed and irrigated crops .

Table 23: Net return from rainfed and irrigated crops

	Rainfed crop		**Irrigated crops**	
	Maize	**Teff**	**Tomato**	**Onion**
Area(ha)	147.25	45.3	20.03	20.15
Production(qt	4773	363	15527.6	725
price(Birr/qt)	200	600	200	300
Gross revenue(Birr	1987895	380520	653478.75	556140
Cost Item(Birr				
Seed	65291.13	10668	20250	7086
Fertilizer	219746	22120.25	15723.55	10075
Chemicals	665.5	1902	10816.25	750
Oxen	117800	36240	9614.4	9672
Labour	172282.5	81540	30465.63	30648.15
Total cost	575785.1	111700.3	86869.83	58231.15
Net return	1412109.9	268819.7	566608.92	497908.85
Net return per hectare	9589.88	5034.20	28288.01	24710.11

Source: Own Survey, 2011

Rainfed crops possible, land size for each crop under rain fed and irrigated farm was transformed into one hectare and accordingly, inputs and outputs mean values for each crop was computed. The result indicates, Table 23 shows that there is a huge difference between mean incomes to be generated between rainfed and irrigated farms.

From irrigated farms, net return from onion is Birr 24710.11 per hectare and for tomato it is Birr 28288.01/hectare. In case of rainfed, the net return from teff is Birr 5034.20/hectare. Similarly, the net return from maize is Birr 9589.88/hectare. From this analysis, it is possible to note that a farmer who is involved in the production of onion instead of teff and maize generates net return, which is 4.9 times and 2.57 times more than what could be generated instead teff and maize

respectively. Furthermore, farmers who are involved in the production of tomato instead of maize and teff can generate net return about5.61 times than from teff and more than 2.95 times than from maize production.

Table 24: share of income from rainfed and irrigated land

Income from rainfed land only from 152.55hectare		Income Irrigated farm 40.18 hectare				
		First round(creaks)by rainfed		Second round irrigated (vegetables)		
Maize	Teff	Maize	Teff	Tomato	Onion	
1122687.3	218477.7	289422.6	50342	566608.92	497908.85	Total = 2745447
Sum =1341165		Sum =1404282				

Source: Own Survey, 2011

The survey result also shows that from 79.2 % of land under rainfed production, only 48.86% of income is generated while from 20.8% irrigated land, 51.14% income is obtained. Om irrigated land irrigation users produce in the first round cereals and in the second round vegetables and obtain high income. According to the fact on table 24from 152.55 non-users gain 1341165 birr which is 8791.64 per hectare but from 40.18 hectare of land irrigation users earn 1404282 which is 34949.77 per hectare .In this case it is about four fold when compared 8791 .64 per hectare of rainfed farm .The income difference between irrigated and un irrigated is may be from the productivity of irrigated land and the intensity of and frequency of cropping on the same land in one year. The productivity and intensity of irrigated farm has great contribution of small scale irrigation to house hold and food security

According to the information gathered from GWADO, the intensity of irrigated crop is 200%, i.e. twice from the same land. In fact, there are cases where few farmers intensify their cropping up to 300%, i.e. they produce three times on the same land. That means, they can produce/obtain income twice and three times on the same land that makes the benefit of irrigation multiple benefit than the none irrigated farming.

4.8. Food Security Status of Sampled Household

Farmers who have access to irrigated agriculture increased cash income through increased production and productivity of high value crops. The findings of this study indicated that through production of high value crops (vegetables, onion and tomato, farmers were able to generate a good amount of income, which contributed significantly to households' crop income. This revealed that irrigated farming has paramount contribution to household crop income in the study area. Besides, irrigated farming has positive contribution to household food security through its contribution in production of subsistent crops and building the capacity of farmers to purchase food crops.

The result of this study also shows that income from irrigated vegetable crops is found to influence through its effects on enhancing household subsistent crop production and trade based entitlements.

The food security status of any household or individual is typically determined by the interaction of a broad range of agro-environmental, socio-economic and biological factors. As with the concepts of health or social welfare, there is no single, direct measure of food security. However, the complexity of food security problem can be simplified by focusing on three distinct but interrelated dimensions: aggregate food availability, household food access, and individual food utilization (WFP, 2009), which are the three distinct variables that are essential to the attainment of food security. Depending on the arguments presented so far, the contribution of irrigation to household food security is analyzed by different angles in the forth coming sections.

4.8.1. Food Availability

Physical presence of food in the area is increased due to irrigation facilitating the production to be twice and three times on the same farm land. Vegetables are available for local market for the non-users of irrigation and surrounding people. As the responses of key informants and focus group discussion confirm, the type of vegetable produced in the study area can increase the availability of food items in study area. Irrigation increase fresh vegetable in the area and through market mechanisms increase the availability of food items at household levels and nearby markets. This availability is acquired both in quantity and variety.

The SSI scheme users of study area could diversify their production from producing only cereals (Maize) but also enable the production of onion, tomato, carrot and cabbage. By planting these crops, as observed and surveyed, they could diversify the source of food items.

To get the food security status of household, a modified form of simple equation termed as Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and thenceforth used by different researchers in this field (Eshetu, 2000; Mesay 2009) was used to calculate the per capita food available in Household Food Balance Model NGA = (GP + GB + FA + GG) - (HL+ GU + GS +GV) Where,

NGA= Net grain available/year/household
GP= Total grain produced/year/household
GB= Total grain bought/year/household
FA= Quantity of food aid obtained/year/household
GG= Total grain obtained through gift or remittance/year/household
HL= Post harvest losses/year
GU=Quantity of grain reserved for seed/year/household
GS=Amount of grain sold/year/household
GV=Grain given to others within a year (Mesay, 2009).

The net grain available was converted into calorie, and divided the calories figure by the number of Adult Equivalent (see Table **2** in Appendix for conversion factor) in the household and then the result also divided by 365 days which results in a figure for average calorie available per AE per day in a household.

Based on the result, households were categorized into food secured and food insecure taking 2100 kcal available per AE per day as cut off point (Hoddinott, 2001), which is the minimum calories required for AE per day. From the total sample households, 63.3% households were food secured where as the remaining 36.7 households was food insecure. (Table 26)

Table 26:Food Security Status

Food Security Status	Users		None Users		Total	
	n	%	n	%	N	%
Secured	59	78.7	36	48	95	63.3
Insecure	16	21.3	39	52	55	36.7

Source: own survey 2011

The food security situation between irrigation users and non-users was different. The irrigation users were in a better position than that of non-users because about 76% of irrigation users were food secured where this was only 48% for non-users.

Further analysis was made to see the position of sample households with regard to calorie available. To this effect, the data on household calorie available per AE was categorized taking 2100 kcal as a cut of point. Those households more than this value are food secured but with different value and less are food insecure (Table 25)**.** From Table 25 it is also possible to conclude that there is difference within food secured households in terms of calorie availability where 37% of sample households of irrigation users food secured have more than >2500 kcal as compared to 8% of the non-users.

Table 25: Available kilocalorie

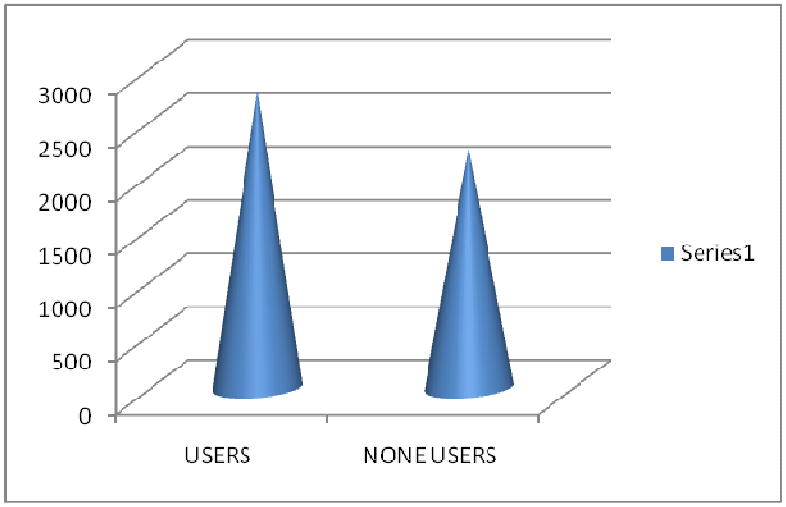
Kcal	User n=75		None user n=75		Total(n=150)	
	n	%	n	%	n	%
>1500	-	-	18	24	14	9.3
1500-2099	18	24	20	26.7	38	25.3
2100-2500	20	26.7	31	41.3	55	36.7
2501-3500	27	36	6	8	33	22
>3500	10	13.3			10	6.7
Mean	2786.83		2238.15		2512.49	
Std. Deviation	730.57		569.90		708.62	
t-value	33.04		34.01		43.43	

Source: Own Survey, 2011

This analysis implies that irrigation users who were food secured were in a better position than non-users in terms of amount of calorie availability. By household food balance model, the survey result shows that irrigation user were better by available food energy in kCal.

This can further observed from Figure 8 where the mean available klcal of users is 2786.83 and 2238.15 is for non-users.

Figure 8. Mean available klca



Source: Own Survey, 2011

4.8.2 Food Access

Food access concerns a household**'s** ability to acquire adequate amounts of food, through one or a combination of own home production and stocks, purchases, barter, gifts, borrowing and food aid (WFP,2009). Access to food for this work is defined as ability of a household to marketable and produced food. The level of access is assumed to be affected by availability of cash income.

The impact of irrigation in income level was gathered from key informants and focus group discussions. According to the results, the ability to acquire adequate amount of food from irrigation users household's increased because they participate in irrigation development through one or a combination of own home production and stocks, or purchases. According to the responses from FGD, irrigation users diversified food crops and livestock product are accessed

by irrigation users than non-users. By income from irrigation, the users tend to purchase different food items from market and shops. Food is more accessible to irrigation user households than acquire a sufficient quantity or diversity of food through different mechanisms than non-users. The FGD with the users and KI of Gobu Sayo Wereda Agricultural Development Office survey result confirm that access of vegetables on dry season in the market and own consumption create the access to food in the area from users production.

The existence of SSI enables users to get income through-out the year because they are privileged enough to harvest tomato, onion and vegetable crops when they are less in the market. Moreover, this supply during non-harvesting times helped users to claim better prices for their products and the presence of vegetables on the market in the dry season also helps the non-users to benefit from available products in the market and create access of food.

The survey result showed that irrigation users obtain more double income than non-users. The increased income of irrigation users help them to buy additional cereal crops and other food items from market and this is one of the food access that is benefited from small scale irrigation. The survey result confirms that 59% of irrigation users start to use hired labor to solve the labor shortage, which in a way can create food access as the result of the wage the employees earn.

4.8.3. Food Utilization

Food utilization means ensuring a good nutritional outcome, which is nutrition security. This study did not assess all the dimensions of food utilization, but analyzed the gain from agricultural income increases. As income increases, an increase is expected in the consumption of quality food such as pulses, fruits, milk and dairy products, which, while adding to calories, contribute significantly to the increase in other nutrients particularly lacking in the diets of the poor. As was observed in the field, the farmers grow cabbages, onions and tomatoes that do help relieving malnutrition.

Utilization is considered as ability of household to get more types of food and increased number of meal per day. From the subjects in the study area, irrigation users reported that they benefited from improved nutrition, both from direct consumption of the additional crops they grow and from having more income to spend on food. The benefit to children in particular was emphasized.

The KI from irrigation users reported that this has brought health benefits, which in turn reduced household expenditure on health care.

4.8.4. Food diversity

The numbers of different foods or food groups consumed in a household provide a measure of quality. It is evaluated in terms of the variety of food groups (meat, milk, fruits, and vegetables) consumed.

Additional income can serve to increase the quantity and quality of the diet. The number of different foods or food products such as milk and milk product groups consumed in a household provides a measure of quality of the diet by reflecting dietary diversity. These are grain legumes, roots, meat, milk, poultry and eggs, and vegetables. The food groups which constitute the livestock products are preferred foods and their consumption is taken as a reflection of social status. According to the data obtained (Table 27), 42.7% and 60% of irrigation users consume milk and vegetables respectively while only 13% and 28% of the non-users consume the aforementioned food types respectively.

Table 27: Different Food Items Consumed

Type of product	Users		None users	
	n	%	n	%
Milk and milk products	32	42.7	10	13.3
Meat	21	28	9	12
egg	15	20	5	6.7
vegetables	45	60	21	28
Fruits	35	46.7	10	13.3
Oil fat	35	46.7	19	25.3
Roots/tubers	42	56	17	22.6

Source: Own Survey, 2011

As can be seen from the table, irrigation users are in a better position in consuming diversified food. This may be due to the diversified production of irrigated farm and income obtained from the same.

Irrigation users consume more diversified food groups than non-users, which have lower income and consumption that can be taken as one reflection of social status. This diversified consumption resulted into the diversification of production and the increased income from diversified high productivity of irrigated farm. According to FGD participants report, the irrigation users are in a better position by consumption of diversified food due to their diversified production.

4.8.5. Increased Number of Eating Occasions

The number of daily eating occasions is a proxy indicator for gauging the adequacy of household FANTA (2005). The household survey questionnaire result shown that more than 65.4% and 25.3% of irrigation users consume three time and four times a day respectively while 29.3% and 8% of the non-users eat meal three and four times. The remaining 52% of non-user eat twice daily.

Table 28: **Respondent Current Dietary Frequency**

House hold dietary time		Irrigation Users		None users	
		Frequency	**Percent**	**Frequency**	**Percent**
Valid	Twice	7	9.3	47	62.7
	Three time	49	65.4	22	29.3
	Four time	19	25.3	6	8
	Total	75	100	75	100

Source: Own Survey, 2011

Regarding eating occasions, focus group discussions and KI responses indicate that irrigation users eat frequently than non-users. This may be due to the availability of food by own production and from market.

4.8.6. Irrigation Decrease the Vulnerability to Food insecurity

As survey result generated from data indicate, during the last five years, only 32% of irrigation users faced food insecurity in the household and more than 61% of non-irrigation users face food insecurity, which is almost twice to the irrigation users.

Table 29: house hold food in security

Questions	Response	User n=75		Non user n=75		Total=150	
Is what you produce last year enough to your family	**Yes**	**n**	**%**	**n**	**%**	**n**	**%**
	No	19	25.3	40	53.3	59	39.3
Household faced food deficits in the last five years?	Yes	24	32	46	61.3	70	46.7
	No	51	68	29	38.7	80	53.3

Source: Own Survey, 2011

Additionally, respondents asked to a question whether or not the last year's production is enough for household consumption. According to the result obtained, only 19% of irrigation users have faced food deficit by self sufficiency but more than 53% of the non-users have deficit for house hold consumption. This happened due to multiple benefits from irrigation farm that led to high productivity and diversified production that could help them from production failure.

From this data, it can be concluded that irrigation users are in a better position than non-users with regard to securing the household with sufficient food.

This may be because of the fact that non-users are producing once a year and if they run out of food before the next harvesting season, they may not have other alternative food sources. In the case of irrigation users, however, they have other options as they can produce more than once a year to supplement the rainfed agriculture. In fact, some of the users also face food shortage that account 17.5 % of them in July, 7.5% of the users in August and 7.5% of them in September.

4.9. Factors Affecting Contribution of Small Scale Irrigation Scheme to Food Security

All surveyed households said that they had improved the food security and income of households. As indicated in Table 30, about 74.7% of irrigation users could not be able to use irrigated farm to their full capacity.

Table 30: Capacity to utilize irrigation farm

Do you irrigate your irrigated farm in full scale?	**n**	**%**
Yes	19	25.3
No	56	74.7

Source: own survey, 2011

Though they produce crops under improved small scale irrigation, small scale irrigation was constrained by various factors. The main constraints seem to include, lack of financial resources, lack of proper training, lack of adequate market for products, lack of labor, lack of improved inputs, shortage of water, prevalence of vegetable diseases, lack of regular supply of agricultural inputs, inadequate extension and credit services, farmers' lack of interest and experience in irrigation, a culture of open grazing during the dry season, and poor maintenance of the physical infrastructure.

4.9.1. Labor

Female-headed and some poor households identified lack of labor as constraining factor to cultivate land along with lack of capital to hire daily labor. These household heads explain these as the main constraining factors as why they have benefited considerably less from irrigation than other groups. During the FGD with WUA committee and DA, there are members of irrigation users who possess up to 3 hectare of irrigated land, which could not be managed by their household level. There are irrigation users start to use hired lbour , but this is not for all irrigation users .

4.9.2. Lack of Skill and Training

The data obtained from focus group discussion that lack of skills is a constraint for not utilizing irrigation farm to the full capacity. Lack of knowledge of relevant agronomic practices and vegetable production were also mentioned as constraints by all focus group discussants. During field observation, preparation of seed-bade, spacing and water applications were scientifically reported skill gaps to constrain the full utilization of small scale irrigation. It was proved that majority of the farmers have limited training in planning, implementation, operation and

maintenance of irrigation schemes. According to the discussion with GobuSeyo wereda agricultural development experts there is also lack of skill and training of development agents.

4.9.3. Market Instability

Farmers in the study area complain the unsatisfactory opportunities to sell their crops in the local markets. Participants of focus group discussion from yet to be irrigated areas mentioned the instability of market as a major challenging problem. Farmers have no access to larger markets due to lack of transport and therefore need to relay on middlemen, for outputs that has been repeatedly voiced as a problem. As a result, according to farmers, output prices are considerably low. This becomes more severe problem when input prices are high relative to the low output prices since that minimizes the farmers' profit margin. This problem of marketing has been also highly appreciated during the discussion with *wereda* officials. All groups of the sample group mentioned that lack of adequate storage and marketing facilities for farm products is a major constraint.

The perishable nature of vegetable products makes the storage problem more acute; that means, vegetables have to be sold in a short time after harvest. Poor access to markets for outputs creates problems for production on a market-oriented basis, whereby lack of markets for tomato and potato after harvest leads to huge loss. One of the key informants from the irrigation users justified that sometimes crops like potato sold less than one hundred birr per quintals, which can not cover the input cost of the product.

4.9.4. Lack of Improved Inputs Supply

Organized input supply, through government or government-supported channels are often available only for the major rainfed season. Farm inputs, especially fertilizer, are scarce and relatively expensive during the irrigation season. According to report obtained from the FGD irrigation use want to grow crops that are needed in the market but they could not get this kind of crop variety. Additionally, farmers want crops that resist crop diseases but they could not get them. The survey result also showed that the absence of improved input supply is the constraints of irrigation development in the study area.

4.9.5. Prevalence of Vegetables Pests and Diseases

Some horticultural crops are highly vulnerable to pests and diseases; often these crops are introduced without accompanying programs of pest and disease management, which drastically reduces yields and the profitability of farming. During focus group discussion, respondents explained that they couldn't plant crops like potato in high amount due to horticultural disease and pest. Further, they could not completely produce pepper due to crop disease. Also there were a chances to visit the irrigation plots that the crops were damaged by pests and diseases.

4.9.6. Farmers' Lack of Interest and Experience in Irrigation

During focus group discussion participants reported that even though there were active participants in irrigation development in the study area, there were farmers that have yet not started to benefit from the irrigation scheme. Due to this, the scheme was not utilized in full scale and could not contribute to food security and food production.

4.9.7. Water Loss and Poor Maintenance

Poor maintenance of the physical infrastructure is also found to be one of the most important factors responsible for water scarcity in downstream areas of the projects. Except some part of the main conveyance canal, field and distribution canals are earthen constructions that have not been lined with cement. This resulted in water logging in some irrigable plots, seepage water loss, and these led to water scarcity in downstream areas.

Water shortage is also a challenging constraint, often resulted from a mixture of management issues and physical shortages. In this case, farms lying far from the water source tend to be most affected. The irrigation scheme was designed for a limited number of users based on water availability, but other farmers from upper side have informally expanded the scheme leading to water shortages during the irrigation season, in which as a result, crop intensification is hardly achieved. (See Figure9).

Figure 9 –Parts of destructed water structure

Photo by researcher, 2011

Chapter Five

Conclusions and Recommendations

This chapter presents and brief the conclusion depending on the findings and discussed on previous chapter and recommendation for better improvement of small scale irrigation to contribute for house hold income and food security food security .

5.1. Conclusions

Conceptually, the benefits of irrigation are realized through improvements in: agricultural productivity, employment and wages, incomes, consumption, food security and overall socio economic welfare. Irrigation can benefit the poor through increased yields, lowering the risk of crop failure, and generating higher and year-round farm employment. It can enable smallholders to adopt more diversified cropping patterns, and to switch from low values subsistence production to high-value market-oriented production.

The study result revealed that access to such small scale irrigation can significantly improve income level and food security status of beneficiary households. Farmers who participated in irrigation were able to use more agricultural inputs and accordingly generated high income. Furthermore, irrigation users were in a better position in terms of livestock and oxen ownership, asset value, and income from livestock. Therefore, in order to increase the rural households' income and thereby build their asset and enhance their capacity to purchase food items, agricultural inputs, services etc. expansion of small scale irrigation in the study area using available water resource is a crucial factor. The result also gave insight that the farmers were able to generate more than four times additional income than that of rainfed farms through irrigation.

The results of the study also showed that irrigation users were in a better position in terms of livestock (6.76 to 3.92 TLU) and oxen ownership (2.2 to 1.5 TLU), asset value (Birr 36482.76 to Birr 14613.92), participation in credit (76% to 27.7%) and fertilizer use (292 kg/ha to 163 kg/ha). Besides, within irrigation comparison before and after irrigation, participation showed that livestock and oxen ownership was 4.21 TLU to 6.76 and oxen 1.82 TLU to 2.2 TLU before and after irrigation participation respectively and asset value increased from Birr 8634.5 to Birr

36482.76. The result on food security status in the study area shows that larger proportion (78.7%)of irrigation users were found to be food secured where as it was only 48% for non-users.

After receiving access to irrigation, farmers started to produce more than one crop rotation per year, increased their income and consumption levels, and diversified their cropping system. The result of analysis of return to land and management for the rainfed and vegetable crops has significant contribution to the total crop income for the irrigation users.

The study result showed that from 20.8% irrigated land about 51.14% income users' crop income was obtained from vegetables and irrigated farm. This happened due to high productivity and intensity of irrigated farm.

The study result also indicated that income from irrigation was able to support household food security. Irrigation farming is intensive, which requires more use of agricultural inputs. The finding of this study showed that irrigation participants used more inputs like fertilizer and chemicals and involved in agricultural credit than non-users due to high income obtained than non-users. This enhanced irrigation users to pay back their credit debts that enabled them to buy more agricultural inputs than non-users.

The discussion with farmers and site observation revealed that there are problems, particularly in areas of management of the irrigation scheme like water distribution, linkage with government bodies and assignment of management committee. Households also reported a significant increase in investment in livestock (a key asset) and reported that they are better able to meet the costs of living since the introduction of irrigation. It therefore appears that irrigation can make a significant contribution to increasing household resilience and buffering livelihoods against shocks. The benefits suggest that irrigation could be highly beneficial in improving food security poverty reduction and promoting growth. However, Lack of enough knowledge of irrigation management and improved agronomic practices was mentioned as a constraint.

5.2. Recommendations

For irrigation to contribute effectively to food security and growth through supporting income diversification, the right enabling environment is needed. Therefore, in order to develop small

scale irrigation in the study area in particular and in other similar areas in the country in general, the following recommendations were forwarded:

- In order to improve the households' food security and income in the area, attention
- needs to be in place by GOs and NGOs in developing small-scale irrigation schemes and water utilization in efficient and effective way;
- Creating efficient marketing system and linking farmers directly with the marketing system by providing information and facilitating over all conditions in the marketing environment;
- Water must be distributed according to transparent and equitable rules to insure that more farmers share the benefits of irrigation. Appropriate water utilization awareness creation activities are required to be done to enable the users to use it in an efficient and effective way;
- Training for DAs, Wereda Officials and WUA committee members and farmers is required to fill the skill gap of irrigation management;
- Strengthen Farmer Training Centers (FTCs) to train farmers on agronomic practices, marketing, and irrigation development practices are needed;
- The Agricultural Research Center in the study area (Bako), Gobu Seyo Wereda Agricultural Development Office have to create strong linkage to among themselves in order to support the farmers in technology promotion regarding irrigation agronomy;
- Financial support and creating linkage with input marketing agencies in order to avail required agricultural inputs for the farmers involved in irrigation; and
- Post harvest management and storage system technologies are necessary technologies to be introduced in the study area.

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Appendix 1

Appendix I. Tables

Table 1. Conversion factors used to estimate Tropical Livestock Unit (TLU)

Type live stock	Factor
Donkey (adult)	0.7
Chicken	0.013
Horse	1.1
Camel	1.25
Heifer	0.75
Weaned calf	0.34
Donkey (young)	0.35
Calf	0.25
Cow and Ox	1

Source: Stock, et al., 1991.

Table2. Conversion Factors kilocalorie

Food items	Kcal/KG
Maize	3760
Teff	3589
wheat	3623
Barley	3700
Sorghum	3592
Faba bean	3514
chickpea	3732
Lentils	3522

Source: EHNRI, 1968-1997

Table 3. Conversion Factor Used to Calculate Adult Equivalent (AE)

Age	Male	Female
<10	0.6	0.6
10 to 13	0.9	0.8
14 to 16	1	0.75
17 to 50	1	0.75
> 50	1	0.75

Source: Stock, et al., 1991.

Table 4. Conversion Factor Used to Estimate Person-days Equivalent (PE)

Age group	Male	Female
< 10	0.00	0.00
10-13	0.20	0.20
14-16	0.50	0.40
17-50	1.00	0.80
>50	0.70	0.50

Source: Here (1986), John (1982), Ruthenberg (1983) and Nair (1985) cited in storck et al (1991)

Table 5 .Oxen Ownership by Irrigation Users before Implementation of Irrigation

Oxen (No)	**Users n=75**	
	n	**%**
0	**31**	**41.3**
1	**15**	**20.0**
2	**25**	**33.3**
3-5	**4**	**5.3**
>=6	**0**	**0**
Mean	**1.82**	
SD	**0.79**	
t-Value	**15.35**	

TableAsset 6 Value before the Implementation of Irrigation

Asset value (Birr)	**Asset before implementation of irrigation**	
	User n=75	
	n	**%**
<=1000	35	46.7
1001-3000	12	16
3001-7000	12	16
7001-30000	16	21.3
-Mean	8634.5	

Source: Own Survey (2011)

Source: Here (1986), John (1982), Ruthenberg (1983) and Nair (1985) cited in storck et al (1991)

Table7. Oxen Ownership by Sample Households before the project.

Oxen (No)	Users n=75		Non users n=75		Total=150	
	n	%	n	%	n	%
0	31	41.3	22	29.3	53	35.3
1	15	20.0	23	30.7	38	25.3
2	25	33.3	12	16.0	37	24.7
3-5	4	5.3	14	18.7	18	12.0
>=6	0	0	4	5.3	4	2.7
Mean	1.82		2.49		2.19	
SD	0.79		.53		1.67	
t-Value	15.35		8.6		12.87	

Appendix II. Questionnaire

I. Household identification particulars.

Questionnaire number _____

Category_____1. Irrigation participants 2. Non - participant

Name of the household head_____

Date of interview _____

Enumerator's name _____ Signature_____

Checked by _____ Signature_____

II. Household information

2.1. Information on Household Head.

2.1.1 Age of HH head _____ (yrs)

2.1.2 Sex _____

1.Male

2.Femal

2.1.3 Ethnicity 1. Oromo 2. Amhara 3. Guraghe 4. Others

2.1.4 Religion . 1Orthodox 2 Protestant 3 Islam 4 Others

2.1.5 What is the level of education of the household head?

1. If illiterate 2. read and writ 3. 1- 4 grade 4. 5-8 grade 5. 9-12 grade

6. Vocational 7. Others

2. Information on HH- members

N0	Name (Permanent HH Members)	Sex	Age	Relation to HH-Head	Level of education

Code: Sex 1=Male 2=Female

Relationship 1= Self 2=Husband 3=Wife 4=Daughter 5= Son

6 = Grandchild 7=Parent 8=Labourer 9=Sister

10=Brother 11=Step child 12=others

Level of education

1. 0= if illiterate, religious education 2. Write grades starting from grade 1 to 12 3. Write 12 + years for those above grade 12

III. Resource Endowment

3.1. Land resources

3.1.1 Do you have your own land? 1. Yes 2. No

3.1.2 If no to Q.3.1.1, source of land for cultivation is _____

3.1.3 What is the total size of your land? _____in hectare or local units

3.1.4 What is the total area of land you cultivated in 2002 E.C? _____

1. Owned _____ 2. Rented in_____3. Share cropped _____ 3. Received as a gift _____4. Others (specify)_____

3.2. Livestock

3.2.1 Do you own livestock? _____1. Yes 2. No

3.2.2 If yes, indicate type and number of livestock owned currently and five years back.

Type of Livestock		Number(Current	Number before the irrigation project
Cattle	Oxen		
	Cows		
	Heifer		
	Bull		
	Calves		
Sheep and goat			
Mules			
Horses			
Donkeys			
Poultry			
Beekeeping Beehives			

3.2.3. If you don't have enough oxen, how do you get additional oxen you need.?

1. Hire from someone 2. Coupling with other farmer 3. Borrow from friends 4. By Contributing labour to a person who has oxen. 5 .Others (specify) _____

3.3Household assets

3.3.1 If you have the following items currently and before implementation of irrigation, please complete the following table.

Items	Amount		Estimated value in Birr	
	Current	Before	Current	Before
House				
Stored agricultural produce				
Valuables				
Jewelry				
Wrist watches				
Agricultural equipment				
Hoe				
Maresha				
Sickle				
Axe				

Others				
Non agricultural equipment				
Carpenter equipment				
Building equipment				
Others				
Household goods				
Bed Tables & chairs				
Radio/tape recorder				
Kumsaten				
Other kitchen equipment				

3.4 Would you give information on cropping on your irrigation plots for year 2002 /2003 Ec

Crop type	Area (Ha)	Input						Amount Harvested	Unit price (Birr)	
		Seed		Fertilizer		Herbicide and pesticide		Fuel		
		Amount(kg)	Cost (Birr)	Amount (Kg)	Cost (Birr)	Amount (Kg)	Cost (Birr)	Amount (liter)	Cost (Birr)	

IV Agricultural Services

4.1. Credit services

4.1.1. Have you received any type of credit in 2002 E.C? _____1. Yes 2. No

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

Source of credit	Purpose of credit	Total Amount Birr	Interest amount in Birr	Amount paid Birr	Amount unpaid Birr

Purpose of credit: 1. to purchase oxen 2. to purchase grain for food 3. to purchase modern Agricultural inputs like fertilizer and pesticides 4. to purchase farm implements 5. others (specify).

4.1.2 . If no to Q 6.1 why? (Multiple answers are possible)_____ 1.Fear of inability to pay 2. Lack of asset for collateral 3. No one to give credit 4. High interest rate 5. No need for credit 6. Others (specify)

4.1.3. Reasons for unpaid amount (list three main reasons).

1._____2._____3._____

4.1.4. Do you save money ? _____.1. Yes 2. No

4.1.5. If yes to in what form do you save ?(multiple choice is possible) 1. Ikub 2. save in form of livestock 3. Save in Bank 4. Others

4.1.6. During last 5 years your credit need 1. Increased 2. Decreased 3. No change

4.1.7 Have you been trained about credit, interest rate and commitment? _____ yes/no

4.2. Extension Service

4.2.1. Have you got advice in agricultural activities from extension service in year 2002 EC ? 1. Yes 2. No

4.2.2 If yes to Q 4.2.1, Who provided you the advices? (Multiple choices is possible) 1. Government extension officers 2. Farmer group 3. NGOs (specify) 4. Marketing agents 5. Other (Specify)_____

4.2.3 On which area the advice was given? 1. Crop Husbandry 2. Crop diversification 3. Animal husbandry 4.Marketing 5.Irrigation development 6. Post harvest 7. Other (Specify)_____

4.2.4 How often do you get advice?

1. Once a week. 2. Every 15 days 3. once a month

4. Once in three month 5. Once in a season.

4.3. Use of fertilizer

4.3.1 Did you use chemical fertilizers? 1. Yes 2. No

4.3.2 If no for Q 4.3.1 state your reasons in the order of their importance_____

1. Not necessary for cultivated crops _____ 2. Too expensive____ 3. Not available _____ 4. Shortage of income_____ 5.Lack of credit 6. Specify other reasons _____

Type of Crop	**2002 EC**	
	Fertilizer(Qt)	Area(hectare)

V.Household income

5.1. Off- farm income

5.1.1 Do you or any member of your family have off-farm job? ____ 1. Yes 2. No

5.1.2 If yes, indicate the type of work and duration for the year 2002 E.C

Family Member Type of Jobs (see below) Annual Income(Birr)

Family Member	Type of Jobs (see below)	Annual Income(Birr)
1		
2		
3		
4		

if payments were made in kind, convert them to birr at the prevailing price.

Types of jobs - 1. Livestock trade 2. Sale of local drinks 3. Pity trade (grain, vegetables, fruits, etc.) 4. Sell of firewood and grass 6. Daily labour 7. Others (specify)

5.2 Other source of Income

5.2.1 Remittance_____

5.2.2 Others, specify

5.3 Income from Livestock

Income From	**Amount(Birr)**
Sales from chicken	
Sales from egg	
Sales from milk	
Sales from cheese	
Sales from butter	
Sales from hide and skin	
Sales of calves	
Sales of heifer	
Sales of oxen	
Sales of cow	
Sales of sheep	
Sales of goat	
Sales of honey	

Others, specif

5.4.1 Would you give information on cropping on your irrigation plots for year 2002 E. C

Plot No	Crop type	Area (Ha	Input								Amount Harvested D	Unit price (Birr)
			Seed		Herbicide and pesticide		Fertilizer		Fuel			

Crop type - 1.Onion 2. Tomato 3. Carrot 3. Cabbage 4.Lettus 5. Pepper 6. Potato 7.Garlic 8.Others

5.4.2. Have you cultivated your irrigable plot in full scale 1. Yes 2. No

5.4.3 If no to 5.4.2, rank the most important inhibiting factors

Factors	**Rank**
Water	
Labor	
Input	
Credit	

5.4.4. Have you engaged in production of new crops due to participation of irrigation 1. Yes 2. No

5.4.5. If yes to Q 5.4.4 indicate the type of new crops grow 1. Tomato 2.Pepper 3. Lentil 3. Onion 4. Improved maize 5.Others (specify)

5.4.6. Do your family labour force fully utilized due to participation of irrigation 1. yes 2.no

5.4.7. Due you use hired labour 1. Yes 2. No

5.4.8. If yes to 5.4.7, how do you put its trend since last five years 1. Increasing 2. Decreasing 3. No change

5.4.9. How do you rank the household expenditure from income from irrigated farm (highest expenditure is 1 and lowest expenditure is 5)

1. School fees and other costs_____2. Health care_____3. Purchase of food _____4. clothing___5. Festivities_____

5.4.10. Did you participate in rain fed agricultural activity in year 2002 E.C? 1. Yes 2. No

5.4.11 .if yes for Q no. 5.4.10 please provide information on cropping for the year 2002 E.C

Plot No	Crop type	Area (Kert	Input						Amount Harvested	Unit price (Birr)
			Seed		Fertilizer		Herbicide and pesticide			
			Amount (kg)	Cost (Birr)	Amount (kg)	Cost (Birr	Amount (Kg)	Cost (Birr		

Crop type - 1. Maize 2. Sorghum 3. Wheat 4.Teff 5.Haricote bean 6. Barley

7. Others

5.4.12. Number of family members permanently working

1. Full-time on farm _____

2. Part time on farm _____

5.4 .13. Is the family labor enough for agricultural operation 1.yes 2. No

5.4. 14. If no for 5.4.13, how do you get additional labor 1. Hire 2. Exchange 3. Other

VI. Household food security issues

6.1. Indicate the type and amount of food available in the last 12 months in the your home

No	Food Items	Unit	Purchased food	Own production(Kg)	Total quantity available
A	Cereals				
1	Maize				
2	Wheat				
3	Teff				
4	Barley				
5					
	B Vegetables				
	Onion				
	Cabbage				
	Carrot				
	Livestock products				
	Milk				
	Meat				
	Egg				
D	**Other food items**				

6.2 How many times you (your family) used to eat per day in most of the years time?

1. Once/day 2. Twice /day 3. Three times/day 4. four times/day.5 more than four times

6.3 Type of food consumed

Yesterday, did you or anyone in your household consume		
Food Group	Yes	No
Cereals and Grains		
Vegetables 1 0		
Meat, Milk, Poultry and eggs		
Vegetables		
Fruits		
Roots		

6.4. Have you obtained food gift other than food aid ? 1. Yes___ 2. No ___

6.5. Have you ever-received food aid last yearHH ? 1. Yes 2. No

If yes, what is the amount and type?

6. 6. Is what you produce last year enough for your family. ?_____1. Yes 2. No

6. 7. If no for how long does it lasted. _____ Months

6.8 During which month (s) are food shortages severing? Choose according to their severity level? (give rank i.e. for the most severe month put 1 then 2etc)October---- November---- December---- January---- February----March---- April---- May---- June---- July---- August---- September----

6.9 What is your coping mechanism?

Copping strategies Users	
Cattle selling	
Reducing meal	
Sales of small animals	
Off farm employment	
Taking credit	

6.10 I n the last five years availability of food in the household 1. Not increased 2.increased

3. Increased substantially

6.11. Have you household faced food deficits in the last five years? 1. yes 2. No

6.12 What are the months that you face food deficit?

VII .Constraints of irrigation development

7.1 What are the challenges of irrigation development in the area that hinder the irrigation development contribute to food security?

7.13 What kind of support is needed for the future to the small scale irrigation development in the area ?

7. 14 Any coment or suggestion about food security and small scale irrigation in your area ?

Checklist for Focus Group Discussions (FGD and key informants (KI)

Checklist for FGD

1. What motivating factors for households to use the water sources for irrigation purpose?
2. What do you think the position irrigation participants now that you are participating in irrigated agriculture regarding earning an income and food security ?
3. Has the project improved the food situation in your households?
4. what are the challenges of the irrigation scheme?
5. What do you have to say about the extension services you receive?
6. Identify the constraints irrigation activities that limit to fully utilize?
7. What are the major crop types which are produced in the localities?
8. How irrigation is in relation to access and availability of food in the area ?
9. Is there difference between the irrigation users and users regarding the household income and food security?

10 Marketing environments ,challenges and opportunities

Checklist for Key Informants

1. What was the situation of the household food security before the irrigation scheme?
2. What has been the impact of the people's participation in the irrigation scheme?
3. What difficulties are the people facing?
4. What is the situation with the extension services your community receives?

5. What are your recommendations with regard to the implementation of this project?
6. Do you have anything else you would like to say or comment on?
7. What are the major crop types that are used for home
8. What marketing of vegetables looks like?
9. What is Labour cost per day, oxen cost, per day ?

STATEMENT OF AUTHOR

First, I declare that this thesis is my original work and all sources of material used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements of M. Sc. degree at Addis Ababa University and is deposited at the University Library to be made available to borrowers under rules of the library. I also declare that this thesis can be submitted to any other institution, if the university found it necessary. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made.

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