THE EFFECT OF SMALL SCALE IRRIGATION ON HOUSEHOLD FOOD SECURITY IN BONA-ZURIA WOREDA, SIDAMA ZONE, SOUTHERN ETHIOPIA

MSc THESIS

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COLLEGE OF AGRICULTURE

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College of Agriculture
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Examiners' APPROVAL SHEET-1
Submission sheet-2

We, the undersigned, members of the Board of Examiners of the final open defense by ***TEZETA DAMTEW***, have read and evaluated her thesis entitled:" The Effect of Small Scale Irrigation on Household Food Security in Bona Zuria Woreda, Sidama Zone", and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree of **Master of Science in Rural Development**.

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Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the SGS through the SGC of the candidate's School.

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As members of the Board of Examiners of the final M.A. open defense, we certify that we have read and evaluated the thesis prepared by ***TEZETA DAMTEW,*** under the title "The Effect of Small Scale Irrigation on Household Food Security in Bona Zuria Woreda, Sidama Zone", and recommend that it be accepted as fulfilling the thesis requirement for the degree of ***Master of Science*** with specialization in **Rural Development**.

Eden Mengistu(PhD) Chairperson	Signature	Feb 17/2017 Date
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Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the SGS through the SGC of the candidate's School.

Thesis approved by

School head	Signature	22-02-2017 Date

Certification of the final Thesis

I hereby certify that all the corrections and recommendations suggested by the Board of Examiners are incorporated into the final Thesis entitled "The Effect of Small Scale Irrigation on Household Food Security in Bona Zuria Woreda, Sidama Zone".

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STATEMENT OF AUTHOR

I declare that this thesis is the result of my own work and that all sources or materials used in this thesis have been properly acknowledged. This thesis is submitted in partial fulfillment of the requirements for an advanced M.Sc. Degree at Hawassa University and to be made available at the University's Library under the rules of the Library. I confidently declare that this thesis has not been submitted to any other institutions anywhere for the award of any academic degree, diploma, or certificate.

Tizita Damtew _____ _____

Name of student Signature Date

Place: Hawassa University, College of Agriculture, Hawassa

DEDICATION

I dedicate this thesis to my mother (Roman Tadesse), my father (Damtew Brihanu) and my husband (Daniel Mebrate) for tending me with love and for their dedicated parenting in the success of my life.

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First of all, I pay homage and thank God for making all good things happen in my life. I would like to extend my heartfelt thanks to my advisor Dr. Ayele Tessema for his valuable advice, insight and guidance starting from proposal development to the completion of the research work. I would also want to extend my deepest gratitude to my co-advisor, Dr. Fitsum Hagos, for his patience, interest, guidance, constructive comments and useful suggestions throughout the work. Both have worked hard to keep me on the right track and, the accomplishment of this study would not have been possible without their unreserved encouragement, guidance, inspiring suggestions, profound material support and professional expertise.

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ACRONYMS AND ABBREVATIONS

AD	Development Agent
ADLI	Agricultural Development Led Industrialization
BWFEDO	Bona Woreda Finance and Economic Development Office
BWOA	Bona Woreda Agricultural Office
CIA	Conditional Independency Assumption
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
FCS	Food Consumption Score
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HDD	Household Dietary Diversity
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institutes
LIVES	Livestock and Irrigation Value Chain for Ethiopian Smallholder
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
MoWIE	Ministry of Water, Irrigation and Electricity
SNNPRS	South Nation, Nationalities and Peoples Region State
SPSS	Statistical Package for Social Sciences
TLU	Total Livestock Unit

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THE EFFECT OF SMALL SCALE IRRIGATION ON HOUSEHOLD FOOD SECURITY: THE CASE OF BONA-ZURIA WOREDA, SIDAMA ZONE, SOUTHERN ETHIOPIA

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ABSTRACT

Ethiopia's agriculture is dominated by small-scale rain-fed production whose performance is subject to, among others, irregular rainfall pattern. Small-scale irrigation is believed in helping to address this problem thereby reducing rural poverty, food insecurity as well as improving the overall contribution of agriculture to the national economy. The purpose of this study was to assess the effect of small scale irrigation on household food security in Bona-Zuria Woreda. Both primary and secondary data was collected and used in the study. Data was collected from 200 household heads, 100 irrigation users and 100 non-users. Three kebeles was stratified into two strata and random sampling technique was employed to select the sample respondents. Secondary data was collected by reviewing different documents. Descriptive statistics, inferential statistics and binary logistics regression were used for analyzing quantitative data. In the econometric analysis factors that affect the household food security is analyzed using the binary logistics regression. The descriptive statistics revealed that 82% of the users and 46% of non-users are found to be food secure while 18% of users and 56% non-users are found to be food insecure. The major findings of the study indicate that family labor, education level, land size, access to irrigation, health status of household heads and participation in nonfarm activities has positively and significantly affected household food security. In contrast age of household head and dependency ratio has negatively and significantly affected household food security. The study concluded that small-scale irrigation is one of the viable solutions to secure household food needs and diversify their diet composition in the study area. Finally, it is recommended that governmental and non-governmental organization should expand access of small scale irrigation by farm households to improve their food security.

Key Word: Food security, small scale irrigation and Dietary diversity

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Ethiopia is one of the poorest countries in the world, where about 29.2% of its population live below poverty line (World Bank, 2013). Most of the Ethiopian population lives in rural areas and the livelihood of the greater majority of this is based on rainfed agriculture that is subject to highly irregular rainfall pattern with detrimental impact on agricultural production. Moreover, agriculture accounts for over 40% to the GDP, out of which 95% of the production comes from smallholder farmers (MoARD, 2010).

Dependence on natural factors of production as well as small and fragmented holdings, environmental degradation, rapid population growth, low access to new agricultural technologies, traditional methods of cultivation, and low institutional support are identified as factors that keep smallholder production at subsistence level in the country (MoFED, 2012). To address these issues, Agricultural Development Led Industrialization (ADLI) Strategy was designed in 1991 where focus was given to the expansion of small scale irrigation, formation of cooperative societies and access to agricultural technologies to answer the food demand and bring about the socioeconomic development in the country. Irrigation is one of the agricultural technologies defined as the man made application of water to guarantee double cropping as well as steady supply of water in areas where rainfall is unreliable (Mutsvangwa *et al*, 2006). Hence, the development of small-scale irrigation is one of the major interventions to increase agricultural production in the rural parts of the country.

This helps farmers to overcome rainfall constraint by providing continuous supply of water for cultivation and livestock production (FAO, 2003). According to MoARD (2011), the importance of irrigation development, particularly at smallholders level is needed to raise production and ensure food security at household level in particular and national level at large. In addition, irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall. According to (MoFED 2006), irrigation development has already been identified as a source of sustainable economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction (MoFED 2006).

The study area, Bona Zuria *Woreda*, is found in Sidama Zone. According to BWOA, (2015), small-scale irrigation is being practiced in the study area since 1987 E.C. Cognizant of this fact, farmers in Bona Zuria *woreda* has been constructing different small-scale irrigation schemes with the objective of increasing agricultural production and productivity to improve the food security situation of the farming communities and to reduce dependency on the rainfall (BWOA, 2015).

1.2. Statement of the Problem

In Ethiopia, the problem is exacerbated by low production and crop loss mainly caused by low and irregular rainfall among others. Agricultural production is predominantly dependent on rainfall. This has made the country's agricultural-based economy extremely fragile and vulnerable to the impacts of climatic variability which often results in partial or total crop failure and subsequent food shortages and famines. To alleviate the deep rooted food insecurity at household level, the Government of Ethiopia (GoE) has recently introduced

and begun implementation of policies to minimize risk through full or supplementary irrigation (MoFED 2010). Irrigation and water management practices are taken to greatly reduce the problem caused by rainfall variability, enhance productivity per unit of land, and increase the volume of annual production significantly. According to Lipton *et al* (2004 cited in Haile, 2008) state that irrigated agriculture can reduce poverty through increased production and income, and reduction of food prices, that helps very poor households to meet the basic needs by improving their overall economic welfare, protect them against risks of crop loss due to insufficient rain water supplies and promote their use of yield enhancing farm inputs which in the long run enable them to move out of the poverty trap.

In study area there are ten major rives and several spring to be found that can be used for irrigation purpose With this point of fact farmers have been practicing traditional irrigation system such as traditional river diversion and now a days, farmers are being practicing some of the modern irrigation mechanisms especially using water pumps (BWOA, 2015). However, it is not well known to what extent the households that are using irrigation are better off than those who depend on rainfall in the study area. The effect of small scale irrigation on household food security is not yet well studied in the study area. Therefore, the main motivation behind this study is to explore whether irrigation access in the study area is making positive change on household food security or not.

1.3. Objectives of the Study

The general objective of this study is to examine the effect of small scale irrigation on the household food security of the users in Bona Zuria Woreda.

The specific objectives of this study are:

1. To compare the household food security of irrigation users and non-users in study area
2. To determine whether diet diversity between irrigators and non-irrigators are different
3. To identify the determinant factors that affects the household food security
4. To assess factors constraining irrigation use in study area.

1.4. Research Questions

1. Is food production/availability higher among irrigators compared to non-irrigators?
2. Is diet diversity of households with access to irrigation different from those without access?
3. What are the major factors that affect the household food security?
4. What are the factors constraining irrigation use in the study area?

1.5. Significance of the Study

This study analyzed the effect of small scale irrigation on household food security. It identifies the determinant factors that affect household food security and major constraints of irrigation use. The finding of this study can contributes to the strengthening the existing information regarding the topic and helps to conduct further interventions in the area of study. The findings of this study can also be used in guiding policy makers and development planners who are concerned about irrigation development for household food security. Moreover, the

research findings could be used as an input for researchers to further knowledge generation in concepts related to irrigation development and food security.

1.6. Scope and Limitations of the Study

This study was scoped to one administration woreda, three kebeles and respondents. The data of the study were based on a cross sectional survey. The objective of this study was to estimate the effect of small-scale irrigation on rural household food security. The researcher encountered a number of problems during data collection period. One of the main problems was inaccessibility of respondents because they engaged in different social duties and marketing activities. Moreover, inaccessibility of roads in the community has constrained the transportation facilities and I was enforced to walk longer distance on foot. This made the data collection process longer than it was planned.

1.7. Organization of the Study

This research thesis contains five chapters. The first chapter introduces the background; the statement of the problem, objectives of the study, significance and limitations of the study second chapter covers literature review concerning concepts and issues on small scale irrigation and food security in chapter two. chapter three is about methodology, which consists of description of the study area; trends of small-scale irrigation schemes on the study area, research design, sample size, Sampling techniques and procedure, data collection techniques and data analysis. Chapter four presents the study results and discussion part of the research, and finally conclusion and recommendation are presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1. Theoretical Background

2.1.1. Concept of Food Security

Food security has been defined as a situation when all the people, at all times, have physical and economic access to sufficient, safe and nutritious food needed to maintain a healthy and active life (WB and FAO, 2010). The concept of food security is built on four pillars: Food availability refers to physical presence of sufficient quantities of food at a household level, whether from production or markets. Food access refers to people have sufficient resources to obtain appropriate food for a nutritious diet. Food utilization is understood as people have sufficient knowledge of nutrition and care practices and have access to adequate water and sanitation. Food stability refers to the need to assess food in both short and long term (Hartwig *et al*., 2011; Babatunde *et al.,* 2008).

The above discussion relates household food security to the ability of the household to secure food, either from own production or through purchase of adequate food for meeting dietary needs of its members (Nyange, 2001). When analyzing food security at household level we have to look at food supply and distribution, effective access to food by households and effective consumption by individuals (World Bank, 2003).

Household food security implies that each member of the household in general has access to food. Although food availability at the household level is a key issue, there are intra-household factors that may affect equitable and adequate access to food by all members (Maxwell and Frankenberger, 1992). Maxwell and Frankenberg (1992) indicated that

household food security has social linkages including access to health services and good healthy environment, education and adequate care of children and women. These non-food linkages influence households' decisions regarding livelihood resources, such as income and labour which are direct determinant of household food security.

Household food security in developing countries is determined by what a household is able to produce, process, store, prepare and buy from the market. In turn these are determined by the agricultural resource availability to that household such as climate and ecology, the amount and quality of land, the level and type of technology, the availability of production assets as well its economic and social capacity to access food (Maxwell and Frankenberg, 1992).

Food insecurity is defined as a situation where people, individuals at times, lack physical and economic access to sufficient, safe and nutritious food needed to maintain a healthy and active life. According to Frongillo and Nanama (2012), household food insecurity results when food is not available, cannot be accessed with certainty in socially acceptable ways, or is not physiologically utilized completely. Food insecurity occurs whenever enough and safe foods are not available or the ability to acquire such foods is limited.

2.1.2. Food Insecurity Coping Strategies

Food insecurity coping strategies are activities, which maintain food security or combat food insecurity that has occurred at the household level. Coping strategies are directly attributed to household activities rather than external factors. According to literature (Hadley *et al.* 2007; Maxwell *et al*., 2008) there are four categories of strategies, namely consumption, expenditure, income, and migration. Consumption strategies include buying food on credit,

relying on less-preferred food substitutes, reducing the number of meals eaten per day, regularly skipping food for an entire day, eating meals comprised solely of vegetables, eating unusual wild foods, restricting consumption of adults so children can eat normally, and feeding working members at the expense of non-working members. Expenditure strategies include the use of savings and avoiding health care or education costs in order to buy food. Income strategies include, the use of pension, small businesses and selling household and livelihood assets such as livestock. Migration strategies include sending children to relatives or friends‟ homes or migrating to find work (Maxwell et al., 2008).

2.1.3. Household Dietary Diversity (HDD)

Dietary diversity refers to the number of different types of food or food groups consumed over a given reference period (Hodditt & Yohannes, 2002). The dietary diversity questionnaire is based on a set of food group questions and can be used to find a household's dietary diversity score by categorizing different types of food based on nutrients they comprise (Swindale & Billinsky, 2006). A rise in the dietary diversity increases the chances of a household becoming food secure (FAO, 2007). The reasoning is that a household is more likely to have both economic and physical access when on average; it consumes six or a number of various food groups within many food groups (Swindale, 2007).

In both developed and developing countries, a number of studies have showed a positive relationship between household dietary diversity and improved nutritional intake (Throne-Lyman, 2009). The measure of the dietary diversity is based on surveys and monitoring activities. Savy et al. (2006) explain that this measure is much more effective when utilized at the end of the period of food-scarcity in order to identify households that are more affected by

food insecurity. Several authors have criticized the effectiveness of this method. The dietary indicator is most likely to become an effective tool only in households that consume most common foods such as cereal (Swindale, 2007). There is no simplicity with regards to the number of food groups that will indicate adequate clarification on the quality of a diet (FAO, 2008)

2.2. Concept of Irrigation

Irrigation is defined as application of artificial water to the living plants for the purpose of food production and overcoming shortage of rainfall and help to stabilize agricultural production and productivity (FAO, 2005). According MoIWE (2012) modern irrigation has been documented in the 1960s where the government designed large irrigation projects in the Awash Valley to produce food crops for domestic consumption and industrial crops for exports. Irrigation development is being suggested as a key strategy to improve agricultural productivity and to encourage economic development (Bhattarai *et al*., 2007). The adoption of new technology (e.g. irrigation) is the major powerful for agricultural growth and poverty reduction (Norton *et al*, 2010).

Small-scale irrigation is a type of irrigation defined as irrigation, on small plots, in which farmers have the controlling influence and must be involved in the design process and decisions about boundaries (Tafesse, 2007). In Ethiopia, modern small scale irrigation schemes have been constructed by the federal or regional government in order to overcome the catastrophic climatic change and drought since 1973. Such schemes involved dams and diversion of streams and rivers.

2.3. Empirical Literature Review

2.3.1. Problems Encountered in Small Scale Irrigation Participation

Tadesse *et al*, (2004) conduct a study on the economic importance of irrigation in Donny and Bato Degaga small holder's irrigation schemes in the Awash Valley of Oromiya Regional state with the objective of investigating the impact of irrigation schemes on food security. The finding indicated that the challenges of small-scale irrigation are; low fertilizer application, poor on-farm management, inequitable distribution of labor for the maintenance of irrigation canals, irrigation water loss, tendency of considering irrigation infrastructure as government's property and market problems.

A study conducted by Oruonye (2011), inaccessibility to irrigation farmland, Lack of farm inputs, fertilizer and chemicals, lack adequate startup capital and lack of sufficient water are the greatest challenges to sustainable small scale irrigation in the study area. A study conducted by Shimelis Dejene (2006) also indicated that in the Gibe Lemu irrigation scheme the main problems that constrained the supply of adequate irrigation water in the command area were turn abuses, water scarcity, and poor coordination of water distribution. In Gambella Terre irrigation scheme, water scarcity, turn abuses and poor coordination of water distribution were problems irrigation use.

2.3.3. Impact of Irrigation Use on Household Food Security

This study reviewed the economic contribution of small scale irrigation on household food security. The study conducted that small scale irrigation improves farm households' diet, incomes, health and food security (Torell and Ward, 2010). Thus, the study built the model to illustrate the contribution of small scale irrigation in ensuring food security and attracting inward investment in the economy. The study conducted by Abonesh (2006) in eastern Showa using Heckman two stage analyses revealed that those households with access to irrigation are at better position in securing enough food than their counterparts.

Azemer (2006) also studied food security and economic impact of irrigated agriculture in Teletle irrigation scheme of North Shoa Zone. The finding of his study demonstrated better performance of irrigated agriculture in crop production and productivity than rain fed agriculture. A study conducted by Hagos, *et al.* (2009) also indicated that irrigation in Ethiopia increased yields per hectare, income, consumption and food security. Irrigation schemes in South Africa have increased employment opportunities, and stabilized and increased rural wage rates; and increased family consumption of food through enhancing food availability, reducing levels of consumption shortfall, increasing of irrigation incomes and reducing food prices thereby ensure food security Fanadzo (2012).

2.2.3. Determinants of Household Food Security

A study conducted by Epherm (2008) household food security in the north eastern part of Ethiopia are strongly associated with various socio-economic and bio-physical factors that influence the food security status of households were age of household head, dependency ratio, size of cultivated land, total number of livestock owned, manure application, land quality and farmer's knowledge on the effect of land degradation on food security.

According to studies conducted in Ethiopia, ownership of livestock, farmland size, family labor, off farm income, market access, use of improved technology, education, health status, amount of rainfall and distribution, crop diseases, number of livestock, and family size are identified as major determinants of household food security Regassa (2011) and Bedeke (2012**)**.

The study conducted in Nigeria by Oluyole *et al*. (2009) using probit model found out that sex of household, educational level, age of household head and income have positive influence on food security; whereas, households size has negative influence on household food security. However, study, by Sikwela (2008) in South Africa using binary logit model showed that per aggregate production, fertilizer application, cattle ownership and access to irrigation have positive effect on household food security; whereas, farm size and family size have negative effect on household food security. On other hand, Fekadu (2012) using multivariate logistic regression analysis indicated that dependency ratio, household family size and market accessibility have showed significant and negative effect on food security; whereas cultivable land size, access to irrigation, number of livestock showed positive role for food security.

Other similar, study conducted by Bogale and Shimelis (2009) using binary model reveals that age of household head, cultivated land size, livestock ownership, total income of the household, irrigation and amount of credit receive have negative and significant effect on household food security. Similarly, as studied by Beyena and Muche (2010) using binary logit model showed that age of the household head, size of land cultivated, livestock ownership, soil and water conservation practice and oxen ownership have positive and significant relationship with household food security; whereas, education of household head, household size and off-farm/non-farm income have negative and significant influence on household food security.

2.4. Conceptual Framework of Household Food Security Determinant Factors

As clearly discussed in literature review section and as revealed in figure 1 below, that household food security were affected by different factors. The analytical frame work shows that the linkage between household food security and variables assumed that affect household food security in study area. According to their nature, these variables are categorized under four categories. demographic characteristics which include age, sex ,educational level of the household head, family labor and dependency ratio. institutional factors category includes access to credit, health status , market distance, contact with development agent and food aid. socio-economic factors involves, farm size, livestock size and non-farm income activity and technology adoption such as access to irrigation.

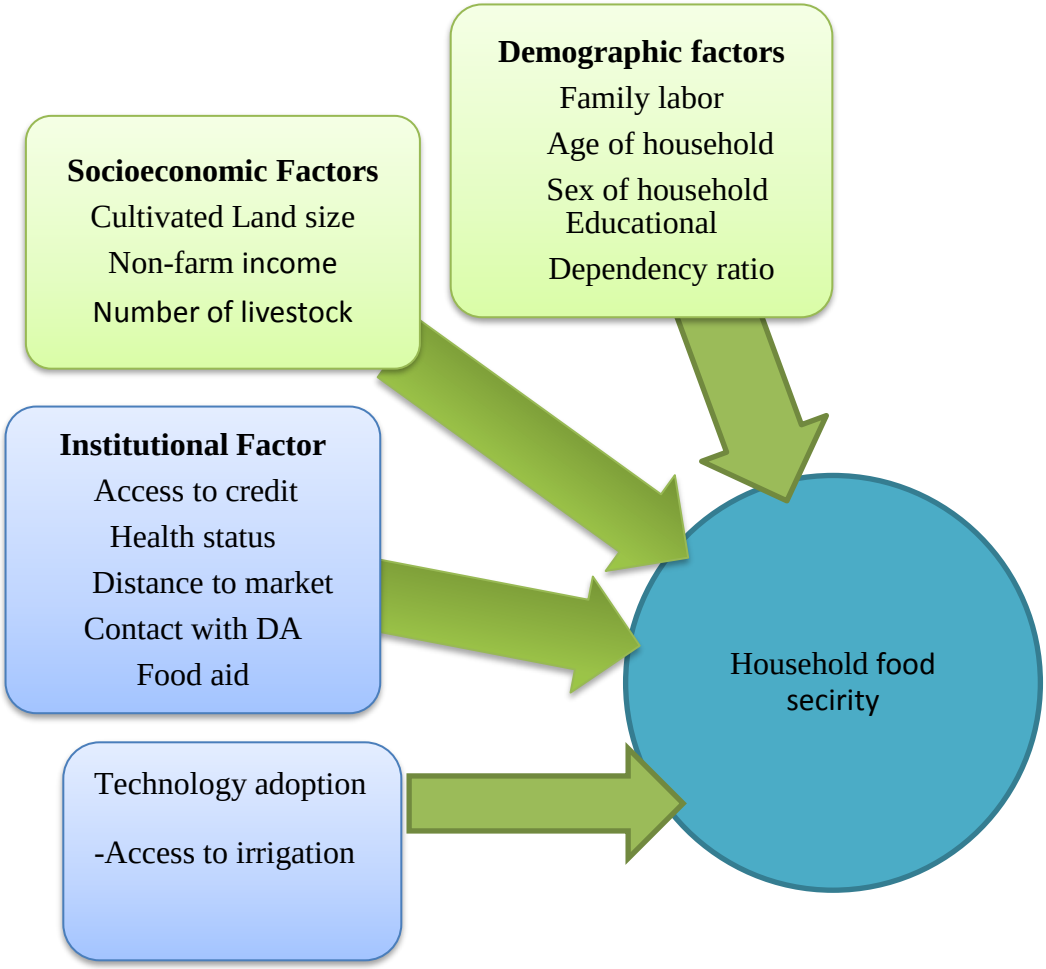

Figure 1: Conceptual Framework of Household Food Security Determinant Factors

CHAPTER THREE

RESEARCH METHODS

3.1. Description of the Study Area

The study area, Bona zuria woreda is found in Sidama Zone of Southern Nations Nationalities and Peoples (SNNP) Region. It is found at a distance of about 386 km south of Addis Ababa. The Woreda comprises 28 kebele administrations. Among these, three of them are urban areas and twenty five of them are rural kebeles (BWFEDO, 2014). It is a newly established Woreda by taking 13 Kebeles from Arbegona Woreda administration and 15 Kebeles from Agere-selam Woreda administration (BWFEDO, 2006).

The total population of Bona Zuria woreda is estimated to be 130,608. Among these 65,480 are female and the rest 65,128 are males (BWFEDO, 2015). According to the same source, the total number of households in the woreda is estimated to be 21,768 households with an average family size of 6 persons per household. There is no adequate and reliable meteorological data to describe the climatic condition of Bona zuria Woreda. However, several data reveals the climatic zone in the study area is temperate (woyina daga) (BWFED, 2006). Mean annual rainfall is estimated at 1030mm while annual range of temperature varies between 16^0C to 28^0C (BWFEDO, 2015). The average altitude of the woreda is 2200 meters above sea level. The area has two cropping seasons. These are belg, usually known as the small rainy season (starting from February to May) and meher also known as the major rainy season (starting from June to September).

Agriculture is the major occupation of the people in the study area. Crop production is rainfed during the rainy season, supplemented for some households by small-scale irrigation in the dry season. Maize, haricot bean, teff (Eragrostis), enset (ventricosum), sweet potato and potato as well as different vegetables and fruits such as tomato, mango, and avocado are widely grown in the woreda. On the other hand wheat, beans, papaya, pepper and onion are grown in small amounts. Coffee and chat are the major cash crops in the study area (BWOA, 2014).

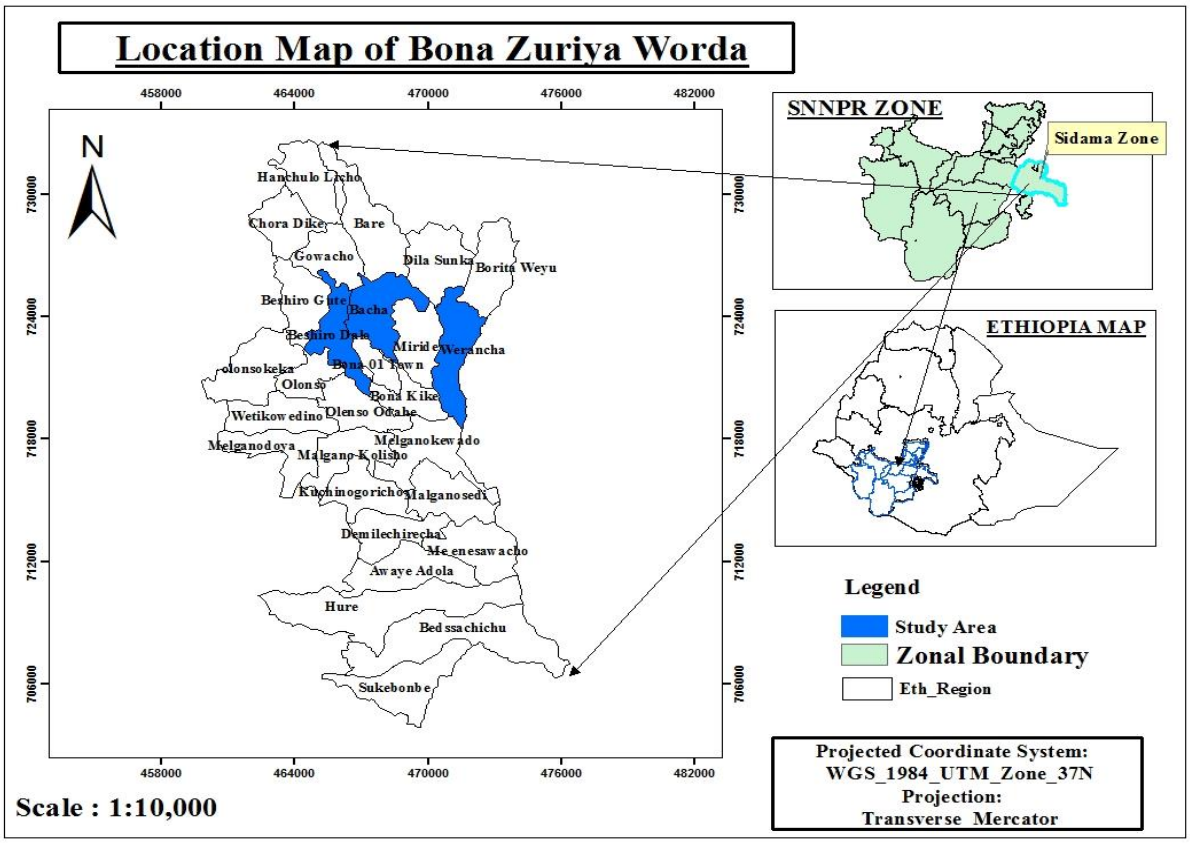

Figure 2: Location Map of the Study Area

Source: SNNPR Agricultural Office

3.1.1. Trends of Small-Scale Irrigation Schemes on the Study Area

Sidama is one of the targeted zones of Livestock and Irrigation Value Chains for Ethiopian Smallholders (LIVES) project in the Southern Nations Nationalities and Peoples Regional State (SNNPR). Bona-Zuria woreda is one of the three woreda that have been selected by LIVES for value chain intervention, the remaining woredas being Arbegona and Bensa woredas. The major livestock and irrigated crops and commodities selected for intervention are dairy, small ruminants, poultry, fruits, vegetables and fodder.

Bona Zuria is one of the consistently agricultural surpluses producing woredas in Sidama Zone. It is believed that the Woreda has a high potential to produce irrigated crops. According to BWOA, (2015), small-scale irrigation is being practiced in the study area since 1987 E.C. At present, both traditional and modern small-scale irrigation systems are being practiced side by side in the study area. Information obtained from (BWOA 2015) indicates that traditional irrigation has a long history in the woreda. Traditional river diversion is one of the irrigation systems and it is simple for farmers to practice by inheriting the knowledge from grandparent but the amount of water and seasonality of rivers are major problems.

Currently modern irrigation scheme like river diversion are introduced and many farmers have adopted various irrigation technologies like motor pump, treadle pump, and rope and washer pump. Several rivers and springs that can be used for small scale irrigation are identified and promoted in the study area such as Morodo, Gelana, Ererte, Dadahe, Gange, Weraje, Melgancho, Namicha, Hayitile and Galalicha rivers. The total irrigable land potential in the woreda is estimated at 6450 hectares. In the study area several crops and vegetables such as

banana, tomato, head cabbage, nursery (coffee and forest), pepper, sweet potatoes, carrot, potatoes and sugar cane are grown by using irrigation.

3.2. Research Design

The research design for this particular study was comparative cross-sectional survey study with both quantitative and qualitative components were conducted.

3.3 .Sampling Technique and Procedure

To select the sample for this study, three-stage sampling method was employed. In the first stage, the study Woreda was purposely selected. In the second stage, three kebeles were selected randomly from those kebeles which have small scale irrigation access. In the third stage, in the three selected sample Kebeles, households were stratified into two strata, namely irrigation users and non-users, from which sample households were randomly selected.

The sample size for the study was identified by using rule of thumb suggested by Green (1991). He suggested that, $n \geq 50+8m$ (where n is sample size of the study and m is number of independent variables). Based on this, the sample size for the study should be greater than or equals to 162 as there were fourteen identified independent variables. But for the purpose of this study, 200 households (100 irrigation users and 100 non users) were determined as a sample size of the study. The main reason for take greater number of sample size was to help reduce the sample error and to enable better generalization on the research objectives. To determine respective samples from the three Kebeles for each stratum, sampling proportion to population was used. Finally, representative sample for each stratum was selected through

systematic random sampling techniques. The following formula was used to determine the sample size of each stratum in the three kebeles.

$P_i = n_i/N$ Where: Pi= proportion of population included in stratum i,

n_i= the number of element

N= the total number of the population

P_i=200/2297 =0.087

Table 1 below shows the respective population of each stratum for the three kebeles with respective proportionate sample size for each of the kebele drawn using this method.

Table 1: Number of Sample Households for Two Strata from each Kebele

Sample Kebele	Irrigation user		Irrigation non users		Total Sample
	Total	Sample	Total	Sample	
Worancha	385	34	363	33	67
Beshiro Dallo	398	35	431	37	72
Becha	359	31	351	30	61
Total	1142	100	1155	100	200

3.4. Data Types and Sources

The studies were used both primary and secondary data sources. Primary data (both qualitative and quantitative) was collected directly from the respondents who were selected from users and non-users of irrigation in each kebele in the way described above. Quantitative data was done by administering pre-tested structured questionnaires. The questionnaires were used to assess socio-demographic, socio-economic characteristics, institutional aspect, food

security status, dietary diversity and Food consumption score in both groups of the households. Qualitative method was used to capture data pertaining to local perception and opinions on the effect of irrigation on household food security. This was done by using one focused group discussion in each of the three selected Kebeles and through key informant interviews.

Secondary data were reviewed and organized from various documents both published and unpublished materials which are relevant to the study.

3.5. Data Collection Techniques

Primary data was collect through various data collection instruments such as household survey, Focus Group Discussion and Key Informants.

Household survey

To generate quantitative and qualitative information at household level, household survey was undertaken by using structured questionnaire. The household survey covered personal data, household resources, production, food consumption and income, issues related to irrigation practice, and food security. The questionnaire was first prepared in English and later translated into the local language (Sidamigna), so that the respondents can easily understand the questions. Three enumerators, one for each kebele, were employed based on their ability of local language and culture, and experiences in data collection. Training was provided to the enumerators on the procedure to follow while conducting interview with respondents and deep discussion was also held to make the questionnaire clear.

Focus Group Discussions

The focus group discussions (FGD) members composed of both men and women those were not involved in the individual interviews. One focus group discussions at each study areas were conducted and each focus group comprised six to eight individuals. The output of the discussion was used as a guide the design of household questionnaire and to get additional supporting qualitative evidence of the on current situation of household food security and challenges that farmers have been faced irrigation activity.

Key Informant Interview

The primary data collected from sample farmers need to be further enriched by additional information gathered through key informants. Thus, intensive interview has been conducted with key informants. Thus, two experts from two different departments, such as irrigation and Productive Safety Net Program expert, one development agents (DA) from each three kebeles, one committee member of irrigation water user's association from each kebeles was included as a key informant interview.

3.6. Methods Used to Assess the Food Security Status of Sample Households

3.6.1. Household Food insecurity Access Scale

Food and Nutrition Technical Assistance (FANTA) Project and its partners have identified a set of questions. Household food insecurity access scale generic questions (in appendix IV) that have been used to distinguish the food secure from food insecure households. The HFIAS consists of two types of related questions. The first question type is called an occurrence question. There are nine occurrence questions that ask whether a specific condition associated with the experience of food insecurity ever occurred during the previous

four weeks (30 days). Each severity question is followed by a frequency-of-occurrence question, which asks how often a reported condition occurred during the previous four weeks. Each occurrence question consists of the stem (timeframe for recall), the body of the question (refers to a specific behavior or attitude), and two response options (0 = no, 1 = yes). Each HFIAS frequency-of-occurrence question asks the respondent how often the condition reported in the previous occurrence question happened in the previous four weeks. There are three response options representing a range of frequencies (1 = rarely, 2 = sometimes, 3 = often) (FANTA, 2007).

The HFIAS indicator categorizes households into four levels of household food insecurity (access): food-secure, mild, moderately and severely food insecure. Households are categorized as increasingly food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently.

3.6.2. Household Dietary Diversity

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods (FAO 2011). Data on household dietary diversity was collected using 24 hours of recall dietary intake. The information collected on dietary consumption allowed to calculate a dietary diversity score, defined as the number of different food groups consumed by household members over 24 hours. A list of meals, all food items and beverages consume in the last 24 hours was recorded.

The twelve food groups, recommended by (FAO, 2006) were used to assess household dietary diversity scores (HDDS). The consumed foods were allocated to the following food groups as

composed : Cereals (1) White tubers and roots (2), Vegetables(3), Fruits (4), Meat (5), Eggs (6), Fish and other seafood(7), Pulse/ Legumes(8), Milk and milk products (9), Oils and fats (10), Sugar or Haney (11), Spices, condiments and beverages (12). Yes and No categories were used. Yes was given a score of one (1) to each food group if the household consumed at least one food item within 24 hours. No was given zero (0) score for a particular food group if the household did not consume any food item from that food group.

Finally the scores were counted from each food group and household dietary diversity scores (HDDS) were calculated based on the FAO guidelines for measuring household dietary diversity. A HDDS of less than 3 food groups was regarded as low household dietary diversity. Four to five food groups was regarded as medium dietary diversity and ≥6 food groups was regarded as high dietary diversity.

3.6.3. Food Consumption Score

To estimate the FCS, foods were regrouped into eight standard food groups (Table 2 below). The Food Consumption Score (FCS), a tool developed by WFP, is commonly used as a proxy indicator for access to food. It is a weighted score based on food frequency and the nutritional importance of food groups consumed. Data was collected on the number of days in the last 7 days a household ate specific food items.

Table 2: Food Items, Food Groups and Weights for Calculation of the FCS

Food items	Food group	Weight
Cereals: Corn, Wheat, Sorghum, Rice, Bread	Staples	2
Roots and Tubers:		
Pulses/Beans/ Nuts Pulses	Pulses	3
Milk/ Milk Products Milk	Milk	4
Animal Proteins: Fish, Meat, Eggs	Meat and fish	4
Vegetables (including green, leafy vegetables)	Vegetables	1
Sugar/ Honey	Sugar	0.5
Fruits	Fruits	1
Oil and Fats	Oil	0.5

Source: World Food Program (2007).

The Household food consumption score (FCS) was calculated by multiplying each food group frequency by each food group weight, and then summing these scores into one composite score. The weighting of food groups has been determined by (WFP, 2007) according to the nutrition density of the food group. In line with the explanations given above, the most basic estimation equation for the Food Consumption Score used for this study is:

$$FCS=a\times f(\text{staple})+\beta\times f(\text{pulse})+\gamma\times f(\text{vegetables})+\gamma\times f(\text{fruit})+\delta\times f(\text{animal})+\varepsilon\times f(\text{sugar})+\delta\times f(\text{dairy})+\varepsilon\times f(\text{oil})$$

Where FCS = food consumption score,

f= frequencies of food consumption = number of days for which each food group was consumed during the past 7 days,

a, β, γ, δ and ε = weight/nutritional value of each food group.

According to (WFP, 2007; IFPRI, 2008), households with poor food consumption have a food score of 0-28, households with borderline food consumption have a food score of 28.5-42 and households with adequate food consumption have a food score of above 42 which is viewed as acceptable.

3.6.4. Household Coping Strategies Index

The coping strategy index is a group of questions that are asked in a household to find out how they manage to cope with the shortage of consuming enough food. The coping strategy index is estimated by measuring behavior, such as the things individual household do when they cannot acquire sufficient food (Maxwell *et al*., 2003).

The coping strategies are often identified by the person who is responsible for preparing or consuming the food. Thus the coping strategies observed are usually linked to food practices in the short-term (Maxwell, 1995). Several studies have used the coping strategy index to measure the extent of household food insecurity. The most common short-term coping strategies employed by households are: eating foods that are less preferred, reduction in the quality of food taken, limiting portion size, borrowing money to buy food and skipping meals.

3.7. Method of Data Analysis

After data collection and editing and coding were completed, it was entered into computer using statistical package for social science (SPSS) version16.0 software. For the purpose of this particular study, the collected data was analyzed in different ways. Based on objectives of the study, both descriptive and inferential statistics and econometric model was adopted.

As descriptive statistics, frequency distribution, charts, mean, maximum and minimum, percentage distribution and standard deviation was employed to analyze the quantitative data. As inferential statistics, chi square was used to identify the associations between categorical variables and independent t- test was also used to compare mean differences between two groups across the study variable, while taking the research objective into consideration. Data that was obtained from key informant discussion and other qualitative data were analyzed in qualitative way. Household Food Insecurity Access Scale (HFIAS) examines the food security status of households. The HFIAS score was calculated using the answers based on the nine frequency-of-occurrence questions. Determinants of household food security were identified using logistic regression model. .

3.8. Model Specification

According to Gujarati (1995), three types of models have been proposed in the econometric literature for estimating binary choice models: the linear probability, logit and probit models represented by linear probability function, logistic distribution function and normal distribution function, respectively. These functions were used to approximate the mathematical relationships between explanatory variables and the food security situation that is always assigned qualitative response variables.

According to Hosmer and Lemeshow, (1989) the major point that distinguishes these functions from the linear regression model is that the outcome variable in these functions is dichotomous. Besides, the difference between logistic and linear regression is reflected both in the choice of a parametric model and in the assumptions. Once this difference is accounted for, the methods employed in analysis using logistic regression follow the same general principles used in linear regression.

Available evidence shows that the logistic function is the most frequently used function in food security studies. According to Hosmer and Lemeshow (1989), there are two primary reasons for choosing the logistic distributions: from mathematical point of view; it is an extremely flexible and easily used function; and it lends itself to a meaningful interpretation. The interest of the study with regard to this objective is to analyze the determinant factors that affect the household food security. For this study, analytical model selected is binary logit model which significantly identifies the food security situation of households.

Binary choice models are appropriate when the decision making choice between two alternatives (food secure and food insecure). Household food security is a dependent variable, which takes a value of zero or one depending on whether or not a household was food secure or not (i.e. Food secure=1 and Food insecure=0).

Following (Gujarati, 1995) the logistic distribution for the food security situation can be specified as:

$$P_i=\frac{e^{zi}}{1+e^{zi}}\text{.....1}$$

Where p_i =was the probability that an individual is being food secure for the i^{th} household and ranges from 0 to 1.e = Represents the base of natural logarithms and

$Z_{i=}$ is the function of a vector of n- explanatory variables(x) and expressed as

$$Z_i=\beta_0+\sum \beta_i X_i+ u_i \text{.....2}$$

Where β_0= is the intercept $B_{i\,=}$ is regression coefficients to be estimated,

$X_{i=}$ is Variables and u_i = is a disturbance term

1-Pi was represents the probability of not being food secured group and can be written as:

$$1\text{-}P_{i=}\frac{1}{1+e^{zi}}\text{.....3}$$

Then odds ratio can be written as:

$\frac{\text{pi}}{1-\text{Pi}}=\frac{1+e^{zi}}{1+e^{-zi}}=e^{zi}$ ……..4

Equation (4) was indicates simply the odds ratio. It was the ratio of the probability that the household was food secure (P_i) to the probability that he/she was food insecure. Finally, by taking the natural logarism of equation (4) the log of odds ratio could be written as:

$L_i=\text{Ln}\left(\frac{\text{pi}}{1-\text{Pi}}\right)=\text{Ln}\left(e^{\beta 0+}\sum_{j=1}^{n}\beta_j x_{ij}\right)=$ $Z_i=\beta_o+\sum_{j=1}^{n}\beta j x ij+ui$……..5

Where Li was log of the odds ratio, which was not only linear in X_{ji} but also linear in the parameters.

Description of Explanatory Variables

Based on the review of the literatures and practical experiences, explanatory variables which have logical and justifiable rational in determining household food security status are identified. These are presented as follows:

Age of a Household Head (HHAGE): Age is a continuous variable measured in years. It was one of the factors that determine household food security status. Thus, younger farmers are more innovative and open to technological advances and be more willing to adopt a new technology (Diederen *et al. 2003*). Babatunde (2007) and other related studies stated that young head of households were stronger and were expected to cultivate larger-size farm than old heads. Hence, the expected effect of age on household food security could be positive or negative.

Education Level of a Household Head (HHEDUC): It is a continuous variable measured in formal schooling years completed by the household head. Education is expected to have a

positive effect on household food security status. Households with better education level was believed to have a chance to apply scientific knowledge and better manage their farm activities in good manner, hence boost domestic production to fulfil household consumption needs. Based on Amaza *et al.* (2006) and other literatures, the higher the educational level of household head, the more food secure the household is expected to be. Hence, education has positive contribution to household food security.

Household size (HSIZE): It is measured in the number of peoples living in the household converted in to adult equivalent. For farming activity, the labour force in the family is essential in order to be food secured. A household who has more number of family members could share the work load to them and contribute a lot to the food security situation of the specific household. Hence it is expected to influence the food security situation of the household positively.

Dependency ratio (DEPRATIO): Household members aged below 15 and above 64 are considered as dependent and dividing it by household members whose age is between 15 - 64 resulted in dependency ratio (John, 2002). These groups were economically inactive and became burden to other member of household to full fill their immediate food demands. Hence, it is expected that dependency ratio have a negative impact on food security situation of the household.

Health Status of the Household Head (HSHH): To work farming activity, physical wellbeing of the farmer was mandatory. The farmer was able to involve in farming work and management aspect of the farm if he/she is healthy. So, health status of the household head was influence the food security situation. It was measured in days per year that the household

head wassick (out of farming work). Good health status was expected to influence the food security situation of the beneficiaries positively.

Contact with development agent (CONDAGE): Refers to the frequency of contact that respondents made with development agent per month. It was the continuous variable. Farmers contact more with development agent have better knowledge about extension packages including irrigation technology than the others .This enables them to enhance production, which is one of the condition of food security. As a result, positive relationship would be expected between contacts with development agent and food security status.

Access to Credit (ACREDIT) was a dummy variable that takes the value 1 when the household takes loan and 0 otherwise. Credit is very much useful to purchase inputs such as improved seeds, other important inputs including staple food. Hence, farmers who have access to credit would have positive effect on crop production due to use of agricultural inputs which enhance food production and ultimately increase household food security status. Moreover, households with access to credit may purchase food when the need arises. Both pathways indicate that a direct relationship of credit access and household food security.

Total Livestock Holdings /TLU/:This refers to total number of livestock measured in tropical livestock unit (TLU). Livestock is important source of income, food and draught power for crop cultivation in Ethiopian agriculture. Household with more number of livestock have a chance to obtain more direct food or income to purchase foods commodities, particularly during food crisis. Therefore, higher livestock size would increase significantly the status of food security.

Distance to District Market (DISMKT): This is a continuous variable measured in kilo meter. It refers to the distance between the households‟ home and the nearest market”. As the farmer is nearer to a market, the higher will be the chance of increasing the household's income, access to purchase food from market and to sell his/her outputs. It is, therefore, expected that households nearer to market will incur lower transaction cost and can easily access the market the required food.

Access to Irrigation (ACCIRR): was a dummyvariable with values of 1 if the household head has access to irrigation and 0 otherwise. Irrigation, as one of the technology options available, enables smallholder farmers to directly produced consumable food grains or/and diversify their cropping and supplement moisture deficiency in agriculture. In doing so, it helps to increase production. It was assumed to have a direct relationship with household food availability. Hence, those household have an access to irrigation was expected to have positive impact on household food security status.

Cultivated Land size (CULTLAND): this refers to total cropping land cultivated by a household in the past one year production period. It has a direct relation with crop production. A larger size of cultivated land implies more production and availability of food grains. According to Haile *et al*. (2005) and Babatunde *et al.* (2007) and other literatures, food production can be increased extensively through expansion of areas under cultivation. Hence, size of cultivated land was expected to have positive effect on household food security status.

Participation in Non-farm activity (NONFARM): It is a measure of any household member participated in non-farming activities and generated an income in Birr. It was assumed that non-farm income earned by a household is primarily spent on food items such as on food grains, and nonfood items required for household members. Therefore, in this study it was hypothesized in that non-farm income is positively associated with household food security status.

Food aid (FOODAID): The food aid amount kilogram is used as one of the explanatory variables. The existing Productive Safety Net Program (PSNP) and other emergency program increases access to food availability for vulnerable households. Therefore, households received food commodities would fulfill their food gap needs, hence, in this study, it was hypothesized that food aid is positively associated with household food security.

Table 3: Summary of Independent Variables and Hypothesized Signs

Code	Variable definition	Variable type	Measurement	Expected sign
ACCIRR	Access to irrigation	Dummy	1 and 0	+ve
FARMSIZ	Land size	Continuous	Hectares	+ve
EDHH	Educational level	Continuous	Year	+ve
HHAGE	Age of a household head	Continuous	Year	-/+ve
TUL	Livestock holding	continuous	TLU	+ve
NON-FARM	Participation in nonfarm	Dummy	1 and 0	+ve
ACCRED	Access to credit	Dummy	1and 0	+ve
DISMKT	Market distance	Continuous	Kilometer	-ve
CONDA	Contact with DA	Continuous	Number	+ve
HHSEX	Sex of household head	Dummy	1and 0	+ve
FAMLA	Family labor	Continuous	Adult equivalent	+ve
DEPRATIO	Dependency ratio	continuous	Number	+ve/-
HEALTYHH	Health status HH head	Dummy	1 and 0	+ve
RFOODAID	Received to food aid	Dummy	1 and 0	+Ve

Source: Own

CHAPTER FOUR

RESULTS AND DISCUSION

This chapter presents the results and discussion of the study. It is divided into four sub-sections; the first sub section summarizes results by using descriptive statistics such as means, percentages and frequencies to describe the characteristics of sampled households by using explanatory variables. The second sub- section focuses on the measuring of food security using household food insecurity access scale in order to determine the food security status of sample households and focus on household dietary diversity and food consumption score of sample households. The third sub section presents the results from econometric analysis that identifies the factors affecting household food security. Finally, the fourth sub section discusses constraints that affect irrigation use.

4.1. Sources of Income to Sample Households

The results in Figure 3 shows that irrigation user households had obtained an annual mean income of 13309.10 ETB (665.6 USD) from cash crop production while irrigation non-user respondents had obtained mean annual income 9213.77 ETB (460.7 USD). This shows that irrigating households earn higher income from cropping than non-irrigating households. The mean non-farm incomes for irrigating and non-irrigating households were 5979.67 ETB (298 USD) and 3943.89 ETB (197.2 USD), respectively. Irrigating households had larger nonfarm income than non-irrigating households. This shows that there was significant difference of between the two groups.

The total mean annual irrigating household income was 19,288.77 ETB (964.44 USD) while that non-irrigating household was 13,157.66 ETB (657.9 USD). This is the sum of average

income from farm production and nonfarm. The survey result found that irrigation is considered as one of the best technologies for improving the incomes of households.

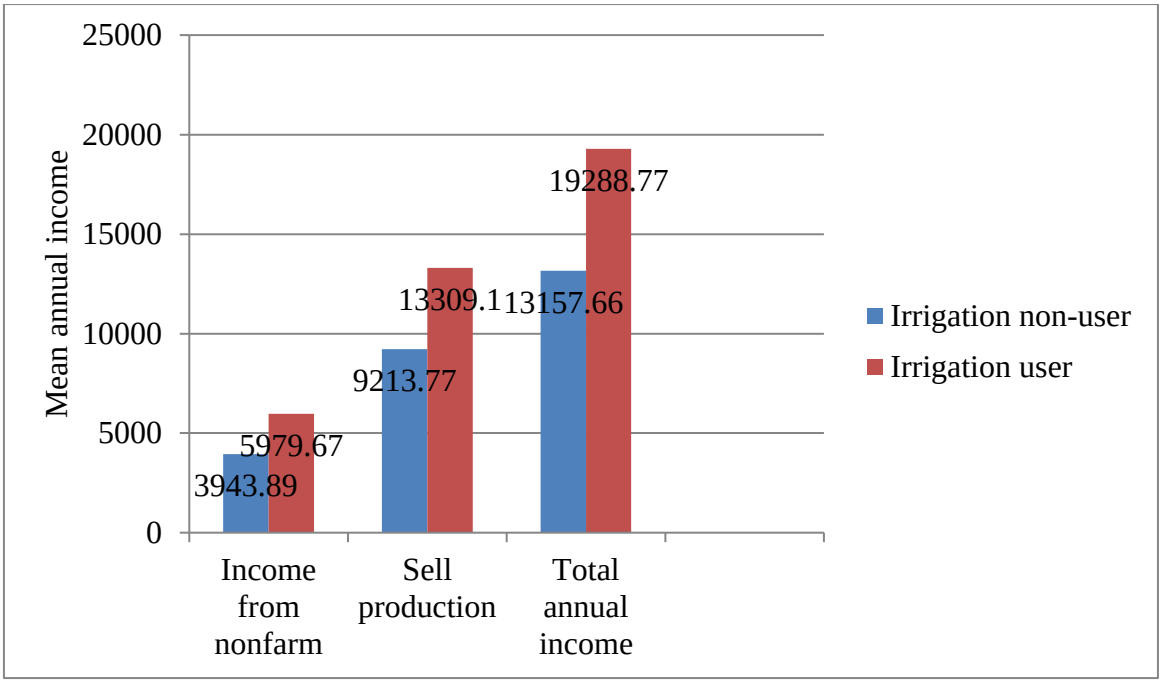

Figure 3: Sources of Households Annual Income

Source: Survey result, 2016

4.2. Sources of Irrigation Water

The survey result in Table 4 shows that out of the total irrigation user respondents, 54% had got irrigation water from rivers while 33% of respondents had got irrigation water from springs. 13% of respondents had used their irrigation water from ponds.

This result also shows that the majority of irrigation user respondents depend on river to irrigate their farm land. Farmers, who had farm lands far from rivers, also used springs. The

ponds were constructed by individual farmers at and near their farm land and used as an alternative source of irrigation water.

Table 4: Source of Irrigation Water

Source of irrigation water	Frequency (N= 100)	Percent
River diversion	54	54
Spring	33	33
Pond	13	13
Total	100	100

Source: Survey result, 2016

4.2. Organizational Support for Irrigation Management

Information gathered from key informants revealed that LIVES project provided training on irrigation water management practice and provision of improved irrigation technologies for the farmers in the study area.

From the total number of respondents who have been practicing small scale irrigation 27% were supported by the LIVES project. From the services or supports of the project 7% of the respondents were provided by improved irrigation technologies, 56% were exposed for improved irrigation practices and 37% were benefited from demonstration of applicable technologies in irrigation. As long as results has been concerned, 18.5% of respondent households were improved their household food security after supported by LIVES project while 81.5% of respondent households were increase their crop productivity. This shows that,

respondent households were more benefited from this livestock and irrigation value chains for Ethiopian smallholders (LIVES) project.

Table 5: Organization Support on Irrigation Water Management

Activities	Frequency (N=27)	Percent
Are you supported by Livestock and Irrigation value chains for Ethiopian smallholders		
Yes	27	27
No	73	73
What benefits did you get from this project?		
Exposure for improved technology	2	7
Exposure for improved practices (practical lessons)	15	56
Demonstration to applicable technologies	10	37
Is there any change on household food security and production after supported?		
Yes	27	27
No	-	-
What is the change?		
Improved household food security	5	18.5
Increase the productivity	22	81.5

Source: Own survey result, 2016

4.3. Description of the Sampled Household Characteristics

This section describes the household characteristics by using descriptive statistics such as mean, percentage, mean difference and standard deviation and inferential statistics such as Chi-square test for categorical variables and independent t-test for continuous variables. The two groups (food security and food insecure) of sample respondents were compared and contrasted with respect to independent variables.

4.3.1. Sex of Respondent Households

The results in Table 6 show that out of 200 respondents, 93.5% of them were males and 6.5% female headed. From the total food secure households 96.9% were males while 3.1% were female headed. Similarly, 87.5% food insecure households were males and 12.5% were female headed. The Chi-square test indicated that the sex of households had significant difference between being food secure and food insecure at 1% significant level. This can be explained that in the study area in particular and the country in general, division of labor is largely governed by gender, which allows men to be responsible for crop production while women are responsible for domestic work.

4.3.2. Educational Level of Respondents

The results in Table 6 shows that 79.5 % of the respondents in the area had formal education whereas 20.5 % had no formal education. Regarding food secure households, 89.8 % had formal education where the rest 10.2 % households had no formal education. On the other hand food insecure households 61.1% had formal education while 38.9% had no formal education. This indicates that households with better educational background are more food secure than households with no education. The Chi-square value shows that the education level of households had significant mean difference between food secure and food insecure household at 1% significant level.

4.3.3. Irrigation Use

As reported Table 6, 64.1% of the irrigation users and 35.9 % of irrigation non-user were food secure households. Similarly, 25% were irrigation users and 75% of the non-users were food insecure households. The result indicated that, participants in irrigation were food secure

than non-participants. The t-value showed that there is significant difference in access to irrigation between food secure and food insecure households at 1% significant level.

4.3.4. Household Health Status

The results in indicated that in the study area out of sampled households 81.5% reported not have health related problem currently while 18.5% of them were suffering from certain sickness (Table 6). Looking into the relationship between health status and food security of the households, 82.5% food secure households reported feeling healthy while the remaining 17.5% were feeling sick. On the other hand, out of the total food insecure households, 80.4% reported having certain health problem currently while 19.4% were suffering from sickness. The t-test shows that there is no significant difference in health status between food security statuses of households.

4.3.5. Contact with Extension Agent

Table 6 showed that the number of contacts per months that the respondents made with extension (a.k.a. agricultural development) agents. 30.5 % food secure households made contact with agricultural development agents more than two times, while 23.6 % of food insecure households made similar contact. 55.5% food secure households made contact with agricultural development agent two times while 56.9 % of food insecure households did make the same contact. 14.1% food secure and 26.4 % food insecure households made contact only once a month. The mean contact of food secure households with agricultural development agents was 1.84 times per month while that of food insecure households was 1.96 time per month. The t-value indicated that there was no significant mean difference of number of

contacts with agricultural development agents between food secure and food insecure households.

4.3.6. Respondent Households Participation in Non-farm Activities

Rural households often engage in different activities rather than the agricultural sector to improved their food security status and income. 47% total sampled households participated in non-farm activities compared to 53 % households who did not participate. Out of the food secure households 52.3% participated in non-farm activities while 47.7% of them didn't. Similarly, 37.5% of food insecure households participated in non-farm activities while 62.5% of them didn't participated ((Table 6). The majority of households have been participating in top four activities: petty trade (43.6%), self-employment (18.1%), sell labor (14.9 %) and (7.4 %) shops. Moreover, some respondents participated in other activities such as food aid (6.4%), Sale of firewood (6.4%) and cash for work (3.2%).

The result shows that more food secure households have engaged in non-farming activities compared to the food insecure households. The result implies that engagement in non-farm activities could be more important to increase the annual income and food availability of farm households. The Chi-square test shows that there is significant difference in participation non-farm activities between food secure and food insecure households at 5% significant level.

4.3.7. Use of Credit

Credit is an important institutional service to finance poor farmers for input purchase and ultimately to adopt new technology. However, some farmers have access to credit while others may not have due to problems related to high interest rate. As indicated in Table 6, out of the

total household sampled only 14.5% of households had access to credit. The majority of sample households (84.5%) had no access to credit service. From the total sampled households, only 10.9% of the food secure households and 20.8% of the food insecure households had received credit in the last three years. The result indicates that food insecure households received more credit than food secure households. The Chi-square test indicated that there was no significant difference in access to credit between food secure and food insecure households.

4.3.8. Received Food Aid

The survey results in Table 6 shows that out of the total sampled households only 8.5% of households had received food aid. On the other hand 16.7 % of food insecure households had received food aid while only 3.9% of the food secure households received food aid. This indicates food insecure households received more food aid than food secure households. The Chi-square test show that there is significant difference in food aid between food secure household and food insecure households, at 1% significant level.

Table 6: Summery of Categorical Variables

	Food secure (N= 128)		Food insecure (N= 72)		Total (N= 200)		X^2
Variable	Frequency	%	Frequency	%	Frequency	%	
Sex of respondent							
Male	124	96.9	63	87.5	187	93.5	
Female	4	3.1	9	12.5	13	6.5	6.664***
Education level of respondents							
Unable to read and write	13	10.2	28	38.9	41	20.5	
Elementary 1-4	51	39.8	38	52.8	89	44.5	
Junior 5-8	47	36.7	6	8.3	53	26.5	43.862***
High school 9-12	14	10.9	-	-	14	7	
Diploma and above	3	1.7	-	0	3	1.5	
Access to irrigation							
Yes	82	64.1	18	25	100	50	27.984***
No	46	35.9	54	75	100	50	
Is there anybody currently sick in your household?							
Yes	23	17.5	14	19.4	37	18.5	0.066
No	105	82.5	58	80.6	163	81.5	
Frequency of contact with DA							
One times	18	14.1	14	26.4	32	16	
Two times	71	55.5	41	56.9	112	56	1.614
More than two times	39	30.5	17	23.6	56	28	
Did you participate in nonfarm activities							
Yes	67	52.3	27	37.5	94	47	
No	61	47.7	45	62.5	104	53	4.056**

What type of non-farming activities your households participated in?							
Hire out labor	5	7.5	9	33.3	14	14.9	
Cash for work	1	1.5	2	7.4	3	3.2	
Food aid	3	4.5	3	11.1	6	6.4	
Sale of firewood	2	3	4	14.8	6	6.4	
Self-employment	15	22.4	2	7.4	17	18.1	
Petty trade	31	46.3	10	25.9	41	43.6	
Village shop	7	10.4	-	-	7	7.4	
Have you received credit?							
Yes	14	10.9	15	20.8	29	14.5	
No	114	89.1	61	78.2	170	84.5	0.007
Did you received food aid							
Yes	5	3.9	12	16.7	17	8.5	9.599***
No	123	98.4	60	83.3	187	91.5	

Source: Survey result, 2016 *** and ** Significant at 1% level and 5% respectively.

4.3.9. Age of Respondent

The mean age of the sample household heads was found 52.24 with standard deviation of 9.59. The mean age of food insecure households was 55.08 years and that of food secure households was 49.40 years. The statistical analysis revealed that there is no significant difference in the mean age of the household head between food secure and food insecure households..

4.3.10. Family Labor

Family size in adult equivalents indicates the sample households average family labor force for agricultural production and other income-generating activities. The average family size in adult equivalents in the study area was 4.07 with standard deviation of 1.63. The result shows that the mean labor of food secure and food insecure households were 4.36 and 3.78 respectively. The t-test shows that there is a significant difference between food secure and food insecure households at 10 % level of significant (Table 7). Thus, food secure households have owned better labor input than food insecure households.

4.3.11. Dependency Ratio

The dependency ratio shows the ratio of economically active persons compared to economically dependent household members. Economically active members of households, whose age is from 14 to 64, were assumed to be the principal productive force and sources of income for the household ((John 2002). Household members whose age was between 0-14 and above 64 were considered as economically inactive and dependent members of the household.

The dependency ratio for the members of the sampled households estimated to be 0.83, which means every 100 economically active persons, had 83 extra persons to feed, cloth, educate and medicate. The mean dependency ratio of food secure households was 0.61 with standard deviation of 0.31 and that of food insecure households were 1.04 with standard deviation of 0.64 in Table 7. This shows that food secure households had less dependency ratio than food insecure households. Therefore, food secure households were more economically active as compared to food insecure households. The t-test shows that there is difference in mean dependency ratio between food secure and food insecure households, at 1% level of significant.

4.3.12. Household Land Holding

Landholding size under subsistence agriculture plays a significant role in the household food security situation. According to FAO (2009), the size of the land in agriculture influences household food security. As reported in Table 10, the average mean land holding in the study area was 0.91 hectares (ha) with standard deviation of 0.32. The survey result shows that 21 % of total sampled households had 0.1-0.5 hectares of farm land, 46 % of the total sample households had 0.51 - 1 hectares of farmland while 32 % of the total sampled households had 1.01 - 2 hectares of land. It was only about 1 % of the total sampled households had 2.01 - 5 hectares of land.

The mean land holding of food secure households was 1.19 hectares while food insecure households had 0.63 hectare. This shows that in the study area food secure households had larger land size as compared to food insecure households. The t-value shows that there is

significant mean difference in land holding between food secure and food insecure households at 5% significant level.

4.3.13. Livestock Ownership of Respondent Households

Livestock production plays an important role in the study area. Farmers rear livestock for various purposes such as for food (source of egg, milk and meat), means of transport, animal dung for fuel wood and organic fertilizer, and means of transport and source of cash for urgent needs Livestock is also considered as a measure of wealth in the rural area. Farm households having a number of livestock are considered as wealthy farmer in the farm community.

Livestock holding widely varied among the sampled households (Table 7). The average size of livestock holding in tropical livestock unit (TLU) for the total sampled households was found to be 3.15 with standard deviation 2.07. Average holdings for food secure and food insecure households were 3.72 and 2.57 TLU with standard deviation of 2.20 and 1.93 respectively. The survey result shows that food secure households possessed relatively higher number of livestock than food insecure households even though the t-value shows that there is no significant mean difference between two groups.

4.3.14. Distance from Respondents Residence to Market

The result showed that sampled households are located on average of 1.66 km away from district market (Table 7). The minimum and maximum market distance was 0.1 km and 5.50 km, respectively. The mean distance of the food secure and insecure households from the main market source was 2.27 km and 2.06 km respectively. The t-test below shows that there

is no significant mean difference in distance from market between food secure and insecure households.

The survey result showed that households sell their products in different market center. The majority (85.5%) of the sample household sold their product at market in the district capital whereas only 14.5% of households sold their product in the village market (PA) market. The t-value indicated that there was no significant mean difference market distance between food secure and food insecure households.

Table 7: Summary of Continuous Variables

Variable	Food secure (N= 128)		Food secure (N= 72)		Total (200)		t-value
	Frequency	%	Frequency	%	Frequency	%	
Age of household head							
15-64	113	88.3	59	81.9	169	86	
Above 64	15	11.7	13	18.1	28	14	
Mean (SD)	49.40 (9.78)		55.08 (9.39)		52.24 (9.59)		-4.002
0.1-0.5	1		0.8		41	56.9	
0.51-1	67		52.3		26	36.1	
1.01-2	58		45.3		5	6.9	
2.01-5	2		1.6		-		-
Mean (SD)	1.19 (0.38)	0.62 (0.28)		0.91 (0.33)			12.183**
Dependency ratio	0.61 (0.31)	1.04 (0.64)		0.83 (0.48)			-5.302***
Family labor	4.36 (1.55)	3.78 (1.17)		4.07 (1.63)			2.977*
TLU	3.72 (2.20)	2.57 (1.93)		3.15(2.07)			3.693
Market distance	2.27	2.06		2.17			1.121
What was your market place?							
Market in the PA	15	11.7		14			
Market in the district capital	113	88.3		58			

Source: Survey result, 2016 ***, ** and * Significant at 1% level, 5% and 10% respectively

4.4. Food Security Status of Sample Households

The second objective of the study was to compare household food security between irrigation users and irrigation non-user households. Household food security was assessed and the results are present in Table 8. The categorical household food security status was based on the household food insecurity access scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) project of USAID. The scale provides a continuous measure of household food insecurity which can be categorized into four levels of household food insecurity (access) prevalence.

The result shows that out of total sampled households 128 (64%) of households were food secure and 72 (36%) of households were food insecure in the study area. Majority (82%) of irrigation user households were food secure, 6% of irrigation user households were mildly food insecure while 10% of irrigation user households were moderately food insecure and only 2% of irrigation user households were severely food insecure. Similarly, out of total non-user 46% were food secure, 11% of non-user were mildly food insecure while 28% of irrigation non-user were moderately food insecure and 15% of non-user were severely food insecure. The result indicates that irrigation user households more food secure than irrigation non-user households. The Chi-square test shows that there is significant difference food security status between irrigation users and irrigation non-user at 1% level of significant

Table 8: Household Food Security Status

Household food security status	Irrigation user (N= 100)		Irrigation non-user (N=100)		Total		X^2
	Frequency	%	Frequency	%	Frequency	%	
Food secure	82	82	46	46	128	64	
Mildly food insecure	6	6	11	11	17	8.5	
Moderately food insecure	10	10	28	28	38	19	
Severely food insecure	2	2	15	15	17	8.5	
Total	100	100	100	100	200	100	27.984***

Source: Survey result, 2016 ***, Significant at 1% level

4.4.1. Household Food Consumption Score

The data on food consumption of 200 households was collected for this study designed for capturing the variety and frequency of different foods consumed over a 7 day recall period.

Table 9 below shows results of sample households' food security status using Food Consumption Score for both irrigation using and non-irrigation uses households. By using the Food Consumption Score cut-off, the results showed that irrigation users with acceptable food consumption were 72% while 18% irrigation users had borderline consumption and 4% of the irrigator households were with poor food consumption score. Out of the total non-users with acceptable food consumption were 44% while 33% the households had borderline consumption and 23% with poor food consumption score.

According to the Food Consumption Score, households with poor consumption are regarded as food insecure, while households with borderline consumption are categorized as moderately food insecure and the households with acceptable food consumption were categorized as food secure. The mean Food Consumption Score for irrigation users were 2.70 and the mean Food Consumption Score for irrigation non-users were 2.19. As indicated in Table 9 below shows that there is significant mean food consumption score difference between irrigation users and irrigation non-user at 1% level of significant

Table 9: Household Food Consumption Score

Food consumption score	Irrigation user (N= 100)		Irrigation non-user (N= 100)		Total		X^2
	Frequency	%	Frequency	%	Frequency	%	
Adequate food consumption (>42)	78	78	44	44	122	61	
Borderline food consumption (28.5-42)	18	18	33	33	51	25.5	
Poor food consumption(≤28)	4	4	23	23	27	13.5	
Total	100	100	100	100	200	100	
Mean	2.74		2.21		2.45		26.907***

Source: Survey result, 2016 ***, Significant at 1% level.

4.4.2. Household Dietary Diversity

The results of survey in Table 10 show that more than half (68%) of irrigation user households and 43% of irrigation non users had consumed high dietary diversity of greater or equal to 6 food groups. Similarly, 29% and 26% irrigation users and irrigation nonusers, respectively, had medium dietary diversity of 4-5 food groups. It is found that only 3% of irrigation users had consumed low dietary diversity of less than 3 food groups as compared to 31% of non-irrigation users that consumed the same amount.

The average mean dietary diversity score for the study area was 2.39. The mean of dietary diversity score of irrigation users was 2.65 while that of irrigation non-users was 2.12. The result indicated that irrigating households had high mean dietary diversity score than non-irrigating households. This shows that irrigating households ate more diversity of food groups than non-irrigating households. The difference the mean diversity scores between food secure and food insecure is significant at 1% significant level.

Table 10: Household Dietary Diversity

Dietary Diversity (DDS)	Irrigation user (N= 100)		Irrigation non-user (100)		Total		X^2
	Frequency	%	Frequency	%	Frequency	%	
High(≥6 food groups)	68	68	43	37	111	55.5	
Medium(4-5 food groups)	29	29	26	32	55	27.5	
Low(≤3 food groups)	3	3	31	31	34	17	
Mean	2.65		2.12		2.39		24.229***

Source: Survey result, 2016 ***, Significant at 1% level.

4.4.3. Major Coping Mechanisms to Food Insecurity Sample Households

Households in the study area have various coping mechanisms during food shortage months. This included: consumption less preferable food, reduction in the number of meals, reduction in the quantity of food at each meal, skipping meals, skipping meals for a whole day, reduction in the quality of food taken and reduction in complementary food to children (reduction in the additional food for children) were the major ones.

As indicated in Table 11, consumption of less preferable food was adopted by 20% to cope with food insecurity. Reduction in the quality of food taken was adopted by 20% and reduction in the quantity of food in each meal was adopted by 18.5%. Reduction in number of meals was adopted by 14.5% to cope with food insecurity and it consists of to reduce the meals frequency per day. Reduction in complementary food to children was adopted by 9% and it refers to reduction in the additional food for children during the food shortage time in order to cope. The rest coping mechanisms were skipped meals, and skipped meals for whole days were adopted by 6.5 % and 1.5% respectively in order to cope with food insecurity.

Table 11: Sample Households Coping Mechanisms to Food Insecurity

Coping mechanisms adopted	Frequency	Percent
Consumed less prefer food	40	20
Reduction in number of meals	29	14.5
Reduction in the quantity at food each meals	37	18.5
Skipped meals	13	6.5
Skipped meals for a whole days	3	1.5
Reduction in the quality of food taken	40	20
Reduction in complementary food to children	18	9

Source: Survey result, 2016

4.5. Factors Constraining the Use of Irrigation in Study Area

The fourth objective of the study was to identify the major constraints of irrigation use in the study area. The importance of small scale irrigation in the study area had increased from times to time. The survey results indicate that small scale irrigation had a great potential to improve the incomes and household food security of poor households. However, adoption of small scale irrigation is not an easy matter. The study identified several factors constraints using small-scale irrigation in the study area.

Table 12 shows that 25.5 % of respondents were reported that distance from water source was major constraining of irrigation use, especially, for irrigation non user households in the study area. Farmers who had far-off farm lands from water source didn't use irrigation as it involves high financial, time and labor cost to access the irrigation water.

The result of the descriptive statistics shows that lack of suitable land that can be used for irrigation (irrigable farm land) was the major constraints for 14% of irrigation non-user households. This implies that those farmers whose farm lands were located on sloppy lands. This farm lands were difficult to apply water though gravity force expect other water lifting mechanisms and improved irrigation technology.

The survey result shows that 21% of the respondents had problems of startup capital and irrigation tool in study area (Table 12). The survey result indicated that farmers with no or little capital to buy irrigation technologies and farm inputs such as seeds, fertilizers and

chemicals, they could not engaged in irrigation activities. This is the same result as Oruonye (2011) that lack of adequate startup capital and insufficient supply of irrigation inputs are the main problem.

Lack of effective marketing system was another constraint for irrigation use., Farmers would be discouraged to produce much as they are not getting rational price for their produce i.e. prices go down with high supply as result farmers couldn't store to sell latter because have no storage facilities. As indicated in Table 12 lack of effective marketing system was a major problem for 21.5% of respondents in the study area.

The presence of pests and diseases were the other constraints of irrigation for 18% respondent in the study area. This implies the number of participants and irrigation practices would be reduced as a result crop damage due to pests and diseases as they cannot cover the cost of irrigation use.

Table 12: Constraints of Irrigation Use

Constraints	Frequency	Percent
Distance from water source to farm land	51	25.5
Lack of effective marketing system	43	21.5
Startup capital and irrigation tool	42	21
Lack of irrigable farm land	28	14
Presence of pests and diseases	36	18

Source: Survey result, 2016

4.6. Determinant Factors that Affect the Household Food Security

The logit model was employed to estimate the effects of the hypostasized independent variables on food security status of households. From all sample farmers, 90 were correctly predicted food secure and food insecure categories by the model. The correctly predicted food secure (sensitivity) and correctly predicted food insecure (specificity) of the model were 93 and 84.7 respectively. Thus the model estimated groups of food secure and food insecure accurately.

Eight significant variables were identified out of the hypothesized fourteen variables by estimating a logit model. Among the factors considered in the model, family labor, education level, land size, health status of households, access to irrigation and participation in nonfarm activities significantly and positively affected household food security. Age household head and dependency ratio significantly and negatively affected household food security (Table 13).

Age of household heads affected household food security at significance level of 1% and negatively related to household food security in the study area. The negative relationship implies that older age household heads have less chance to be food secured than younger ones. This is possible because older household heads were less productive and they lead their life by remittance and gifts. They could not participate in other income generating activities. On the other hand, older households have large number of families and their resources were distributed among their members. This implies that, increase in age of the respondents by one year the likely probability of becoming food secure decreased by factor of 0.869, holding

other variables of the model constant. This result is similar with the finding of Fekadu (2008) and Bogale and Shimelis (2009).

Family labor was significantly at 1% significance level and had a positive relationship with household food security. Family size in adult equivalents indicates the sample households average family labor force for agricultural production and other income-generating activities. Large household family size in adult equivalent means a larger amount of labor available to the household. Since households with higher family labor can perform various agricultural actives without labor shortage. The probability of households' food secure increases by factor 2.827 while keeping all other variables constant. Household with large labor force were food secure more than a household with small number of labor force. This result is similar with the finding of study conducted Regassa (2011) and Bedeke (2012**).**

Access to irrigation positively and significantly affected household food security at significance level of 1%. Irrigation user households were by factors 12.918 times more likely to be food secure compared to irrigation non-users, holding other variables constant. This implies that irrigation enables households to grow food crops more than once a year, hence increased production, income and food availability of the household. So it overcomes of food insufficiency in dry or food shortage circumstance and normal seasons. This result is similar with the result of Sikwela (2008) and Fanadzo (2012).

At significance level of 10% dependency ratio negatively affected household food security. The negative relation of dependency ratio of the household indicates that, keeping other variables constant, the odds ratio in favor of food secure decreases by a factor of 0.233 as

the dependence ratio of household increase by one person. Based up on the result, if the households have more dependent labor forces, the less chance to have food secure than the households who have less dependent age groups or economically inactive groups (≤ 15 and ≥ 65 ages). In a household where adults or productive age groups are higher than the nonproductive age groups, the probability of the household to be food secure would be high. This result is similar with the findings of Epherm (2008).

Education status of household head is significant at 1% level of significance and it has positive association with food security status of household. Holding other variable constant, a change in household head education level by one grade, will increase a probability of being more food secure by a factor of 1.526. This implies educated people can more readily utilize new technologies. Thus, being education reduces the chance of becoming food insecure, which makes them to be sufficient in food compared to illiterate household heads. This result is consistent with the finding of Oluyole *et al*. (2009)

Cultivated land size owned by households positively affected households food security at significant level of 1%. The land size of households increased by 1 hectare, probability of food secure was increased by factor 9.165, other variables in the model kept constant. Land size owned is a proxy to wealth status and households with large land size were expected to have diversified the quantity and type of crop produced, which may in turn lead to increased consumption and household food security. This result is similar with the result of Beyena and Muche (2010).

The logistic regression result in Table 13 shows that health status of household heads has positive relationship with food secured household and significantly at 5% significance level. Healthy households were 4.458 times more likely to be food secured compared to unhealthy or patient households. This implies that, healthy households were more active and motivated for any work than unhealthy ones. Hence, they were better in food security than unhealthy ones. This finding is similar with the findings of Regassa (2011) and Bedeke (2012).

Participation in nonfarm activities positively affected household food security at significance level of 5%. This indicates that households who participate in the nonfarm activities were 3.365 times more likely to be food secured compared to non- participating households. Since the money that they earn from nonfarm activity would increase the household's liquidity to make on-farm investments or increase its income to purchase food and, thereby, improve household food security. This is consistence with the finding of study conduct by Regassa, (2011) and Bedeke (2012).

Table 13: The Logistic Regression Result

Independent variables	Coef.	Wald	P-values	Odd Ratio
Access to irrigation	2.559	10.985	0.001***	12.918
Sex of respondents	0.702	0.260	0.610	2.017
Age of household head	-0.148	15.759	0.000***	0.862
Family labor	1.039	10.663	0.001***	2.827
Dependency ratio	-1.455	3.595	0.058*	0.233
Education level	0.422	6.810	0.009***	1.526
Land holding size of respondents	2.215	20.007	0.000***	9.165
Livestock holding in TLU of respondents	-0.097	0.451	0.502	0.907
Market distance	0.077	0.108	0.742	1.080
Health status	1.495	4.085	0.043**	4.458
Access to credit	0.254	0.125	0.723	1.290
Number of contact with DAs per month	-0.613	1.829	0.176	0.542
Non-farm activity engagement	1.214	4.859	0.028**	3.365
Received Food aid	0.337	0.127	0.721	1.401

*** P<0.01 and ** P<0.05 and *P < 0.1

-2Log likelihood = 103.996, LR chi2 (157.371)

Probability >chi2 = 0.0000 Pseudo R2= 0.747

Number of household = 200

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The objective of this study was to assess the effect of small-scale irrigation on household food security. Small scale irrigation has played a key role in enabling sustainable food production where it is well managed by lowering the risk of crop failure. Irrigation also helps to prolong the effective crop growing period in areas with dry seasons by permitting multiple cropping per year.

Food security was measured using a commonly known measure of food security status known as household food insecurity and access scale. The results based on this measurement revealed that 64% of the households in the study area were food secure while 36 % were food insecure. From total irrigation user 82% households were food secure and 46% of irrigation non-user households were food secure. Diet diversity and food consumption score between irrigators and non-irrigators had significant mean difference at 1% significant level.

The result indicated that, irrigation user households were more food secure than non-users households in the study area. Thus, the food insecurity occurrence households with no irrigation practice are greater than households practicing irrigation. This suggests that small-scale irrigation has an important influence on rural household food security. And it is observed that small scale irrigation is one of the viable solutions to secure household food needs in the study area.

The results of the determinants of food security indicate that age of household, education level, cultivated land holding, access to irrigation, dependency ratio, family labor, health status and non-farm activity were the major factors that significantly influence on households household food security. Education, cultivated land holding, access to irrigation, family labor, health status and non-farm activity positively affected the household food security in the study area. Age of household head and dependency ratio negatively affected household food security.

Finally the results of this study indicate, the main constraints for irrigation use and performance of irrigation in the study area were long distance between their farm, lack of irrigable farm land (lack of suitable land that can be for used irrigation), market problem, lack startup capital and irrigation tool, presence of pests and disease.

5.2. Recommendations

Based on the findings of the study the following recommendations are forwarded in order to improve household food security in the study area.

1. The finding reveals that irrigation and food security are positively and significantly related in the study area. Participation in irrigation helps the households to generate additional income and diversification of household food consumption. Therefore, development strategies and programs related with food security through agricultural production should think about the importance of irrigation. Hence, the governmental and non- governmental organization should expand access of small scale irrigation to households in poverty reduction and to improve their food security.

2. Strong regulatory mechanism should be designed to overcome problems related to irrigation use to provide incentives to committed and disciplined farmers.

3 The empirical result reveals that non-farm activities used to diversify the sources of income and increase household food availability. Therefore, the policy makers have to focus on increasing non-farm activities such as petty trade, village shop, self-employment and the like.

4 Based on the study, household with the educated heads are better in food security status than households with non-educated heads in the study. Therefore, it is recommended that the regional and federal governments should provide access to education for farmers.

5 Dependency ratio is found to influence negatively affect household food security status in the study area. This implies that households with larger household size especially with high dependency ratio could not be able to meet the minimum daily requirement. Therefore, regional and federal governments should be strength to expanding an appropriate family planning strategy and training on diversification of livelihood.

REFERENCES

Abonesh Tesfaye, 2006. The Impact of Small Scale Irrigation on Household Food Security and Assessment of its Management Systems: The Case of Filtino and Godino Schem in Ada Liben District, East Shoa, Ethiopia. An M. Sc. Thesis Presented to School of Graduate Studies of Haramaya University. Ethiopia, Haramaya.101p.

Amaza, P.S., Umeh, J.C., Helsen, J.and Adejobi, A.O., 2006. Determinants and Measurement of Food Insecurity in Nigeria: Some Empirical Policy Guide. Contributed poster prepared for Presentation at the International Association of Agricultural Economics Conference, Gold Coast, Australia, and August 12-18, 2006.

Azemer Berhanu, 2006. Food Security and Economic Impacts of Small Scale Irrigated Agriculture in Ethiopia, A Case Study of Telltale Irrigation Project in North Shoa Zone, Oromia Region. Unpublished Master's Thesis, Addis Ababa University, Ethiopia.

Babatunde, R.O., Omotosho, O. A., Ololunsanya, E. O.and Owoloki, G. M., 2008. Determinants of vulnerability to food insecurity: A gender analysis of farming household in Nigeria. Journal of Agricultural Economics. 63 (1): 116 - 125.

Bedeke S., 2012. Food insecurity and copping strategies: a perspective from Kersa district, East Hararghe Ethiopia. Food Science and Quality Management. Vol 5, 2012.

Beyene, F. and M. Muche, 2010. Determinants of food security among rural households of central Ethiopia: An empirical analysis. Q. J. Int. Agric., 49:299-318.

Bhattarai, M., Barker, R. and Narayanamoorthy, N., 2007. Who Benefits from Irrigation Development in India? Implication of Irrigation Multipliers for Irrigation Financing Irrigation and Drainage, Vol. 56, PP. 207-225

Bogale A. and A. Shimelis, 2009.Household level determinants of food insecurity in rural areas of Dire Dawa, Eastern Ethiopia. Afrr. J. Food agric. Nutr. Dev., 9:1914-1926.

BWFED (Bona-Zuria Woreda finance and Economic Development office), 2014.Annual report on total population of Bona Zuria woreda, Finance and Economic Development Office unpublished document.

BWOA (Bona-Zuria Woreda Agriculture Office), 2015. Report on irrigation potential and existing irrigation schemes by region. Bona Zuria woreda unpublished document.

Diederen, Paul, Hans van Meijl, Arjan Wolters, and Katarzyna Bijak, 2003. Innovation adoption in agriculture: Innovators, early adopters and laggards. Cahiers d"Economie Sociologies Rurales 67: 30-50.

Epherm F., 2008. The link between food security and land degradation: Analysis of determinants in drought prone area of north east Ethiopia: A case of Sekota Woreda.A master thesis presented to the school of graduate studies of AUA.

Fanadzo, M., 2012. Revitalization of Smallholder Irrigation Schemes for Poverty Alleviation and Household Food Security in South Africa: A Review. African Journal of Agricultural Research, Vol. 7(13), PP. 1956-1969.

FAO (Food and Agriculture Organization), 2008.Guidelines for measuring household and individual dietary diversity. Rome: Nutrition and Consumer Protection Division.

FAO (Food and Agriculture Organization), 2011. " Guidelines for measuring household and individual dietary diversity", Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO and WFP, 2010.The State of Food Insecurity in the World. Addressing food insecurity in protracted crises. Rome, Italy. 59pp.crises. Rome.

FAO, 2003.Irrigationin Africa South of the Sahara. FAO Investment Center Technical Paper 5. FAO: Rome.

FAO, 2005. Agricultural trade liberalization: Implications for irrigated agriculture. Rome, Italy.

FAO, 2006. FAO Global Information and Early Warning System on Food and Agriculture World Food Programme: Special Report FAO: Crop and Food Supply Assessment Mission Ethiopia.

FAO, 2007.Guidelines for measuring household and individual dietary diversity.

Fekadu A, 2012.Impact of Small Scale Irrigation Schemes on Household Food Security in Western Oromiya, Ethiopia: The Case of Sibu Sire District of Eastern Wollega Zone.M.Sc., Thesis, Haramaya University, Ethiopia.

Food and Nutrition Technical Assistance (FANTA) Project. "Measuring Household Food Insecurity Workshop, Washington, D.C: Food and Nutrition Technical Assistance Project, Academy for Educational Development, 2007.

Frongillo, E. A. and Nanama, S., 2012. Advances in developing country food insecurity measurement, development and validation of an experience-based measure of household food insecurity within and across seasons in Northern Burkina Faso; Journal of Nutrition; 136: 1409 - 1419.

Green, S. B., 1991. How many subjects does it take to do a regression analysis? *Multivariate* Behavioral Research, *26*, 499–510.

Gujarati, D.N., 1995. Basic Econometrics (3rd ed.). McGraw Hill Inc.: New York.

Hadley, C., Mulder, M. B. and Fitzherbert E, 2007.Seasonal food insecurity and perceived social support in rural Tanzania. Public Health Nutrition 10 (6): 544 -551.

Hagos, F., Makombe, G., Namara, R. and Awulachew, S., 2009. Importance of Irrigated Agriculture to the Ethiopian Economy: Capturing the Direct Net Benefits of Irrigation, IWMI, Working Paper 128, ISSN 1026-0862, Addis, Ethiopia.862, and Addis, Ethiopia.

Haile T., 2008. Impact of irrigation development on poverty reduction in Northern Ethiopia (dissertation), National University of Ireland, Cork.

Hartwig de H., Klasen, S. and Qaim, M., 2011. What do we really know? Metrics for food insecurity and under nutrition. Food Policy Journal 36: 760 - 769.

Hoddinott, J. and Yohannes, Y., 2002. Dietary Diversity as a Household Food Security Indicator. Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Hosmer, D. W, and Lemeshew, S., 1989. Applied Logistic Regression. A Wiley- Inter- Science Publication, New York.

John M. 2002. Dependency ratio, population, standard grade Geography [Internet].[cited 2011 June 12]. Available from: http://www.scalloway.org.uk/popu.

Maxwell D., 1996. Measuring food insecurity: the frequency and severity of coping strategies. Food Policy 21, 291-303.

Maxwell, D., Caldwell, R. and Langworthy, M., 2008. Measuring food insecurity: Can an indicator based on localized coping behaviours be used to compare across contexts.

Maxwell, D., Watkins, B., Wheeler, R. & Collins, G. 2003. The coping strategy index: a tool for rapid measurement of household food security and the impact of food aid programs in humanitarian emergencies. Nairobi: World Food Programme.

Maxwell, D.G. 1995. Measuring food insecurity: the coping frequency and severity of coping strategies. Washington, DC: International Food Policy Research Institute.

Maxwell's and Frankenberg, T.R, 1992. Household food security concepts, indicators and measurements. A technical review. Black well scienceltd, New York and Rome. 274pp. Measurement issues and research needs. Food Consumption and Nutrition Division.

MoARD (Ministry of Agriculture and Rural Development), 2011. Small-Scale irrigation situation analysis and capacity needs assessment. Addis Ababa, Ethiopia.

MoARD, 2010. Ethiopia's Agriculture Sector Policy and Investment Framework: Ten Year Road Map (2010-2020).

MoFED (Ministry of Finance and Economic Development), 2006.A Plan for Accelerated and Sustained Development to End Poverty (PASDEP).(2005/06-2009/10). Ethiopia.

MoFED (Ministry of Finance and Economic Development), 2010. Growth and transformation plan (GTP) 2010/11-2014/15, Volume I, Main text. Addis Ababa, Ethiopia.

MoFED (Ministry of Finance and Economic Development), 2012. Performance and Challenges on the Five Year Strategic Plan of Growth and Transformation: Annual Report of MoFED, Addis Ababa, Ethiopia.

MoIWE (Ministry of Water and Energy), 2012. Water Resources Management and Irrigation Policy: Annual Report of MoIWE, Addis, Ethiopia.

Mutsvangwa T. and Doranalli K., 2006.Agriculture and Sustainable Development, Netherlands, The Hague University Press.

Norton, G., Alwang, J. and Masters, W., 2010. Economics of Agricultural Development World Food systems and Resource Use, 2nd Edition, ISBN 0-203-85275-3, 270 Madison Avenue, New York, NY 10016 Master E-Book ISBN Ethiopia. International Journal of Cooperative Studies, Vol. 2(1), PP. 34-44

Nyange, D. (Ed.), 2001. Natural Resource Management and food security. Proceedings of the SADCC. Food Training Program on Agriculture and Natural Resources Development Unit, Morogoro, Tanzania.70pp.

Olyuole, A.K. Oni, O.A., Omonona, B.T. & Adenegan, K.O. 2009. Food security among cocoa farming households of Ondo State, Nigeria. ARPN Journal of Biological Agricultural and Science, 4(5):7-13.

Oruonye, E. D., 2011. An assessment of fadama dry season farming through small scale irrigation system in Jalingo LGA, Taraba State. International Research Journal of Agricultural Science, 1(1): 014 – 19.

Regassa N., 2011. Small holder farmers coping strategies to household food insecurity and hunger in Southern Ethiopia. Ethiopian Journal of Environmental Studies and Management Vol. 4 No.1.

Savy, M., Martin-Prevel, Y., Traissac, P., Emyard-Duvernay, S. & Delpeuch, F., 2006 Dietary diversity scores and nutritional status of women change during the seasonal food shortage in rural Burkina Faso. Journal of Nutrition 136:2625-2632.

Shimelis D., 2006. "Institution management and challenge of small scale irrigation system in Ethiopia: A case study of Gibe Lemu and Gambella Terre in Western Oromiya". MSc Thesis. Addis Ababa University.

Sikwela, M.M., 2008. Determinants of household food security in the semi-arid areas of Zimbabwe: A case study of irrigation and non-irrigation farmers in Lupane and Hwange Districts. Master's Thesis, University of Fort Hare, Alice, South Africa.

Swindale A. & Bilinsky, P., 2006. Household dietary diversity score (HDDS) for measurement of household food access: indicator guide, Version 2.Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, D.C.

Swindale A., 2007. Months of adequate household food provisioning for measurement of household food access: indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project.

Tafesse, 2007.Socio-economic and Institutional Determinants of Small Scale Irrigation hemes utilization in Bale Zone, Oromiya National Regional State. A Master Thesis, Alemaya University.

Thorne-Lyman, A.L., Valpaini, N., Sun, K. &Semba, 2009. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. Bangladesh: American Society for Nutrition.

Torell, G. and Ward, F., 2010. Improved Water Institutions for Food Security and Rural Livelihoods in Afghanistan's Balkh River Basin. Water Resources Development, Vol. 26 (4), PP. 613–637

WFP (World Food Programme), 2007. Food consumption analysis: Calculation and use of the Food Consumption Score in food consumption and food security analysis. Technical Guidance Sheet (draft). Rome.

World Bank, 2003. Agricultural change and food security: World Development Report. Kluwer Academic Publishers, Washington D.C. 145 pp.

World Bank, 2013.

http://www.photius.com/rankings/economy/population_below_poverty_line_2013_0.html.

APPENDIX

Appendix I: Conversion Factor Used to Estimate Tropical Livestock

Livestock	Conversion factor
Caw	1
Oxen	1
Calf	0.1
Heifer	0.5
Goat	0.1
Sheep	0.1
Donkey	0.5
Chicken	0.001
Mule	1.1
Horse	1.1

Appendix II: Conversion Factor for Adult Equivalent Category

Age group	Sex	
	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

Appendix III: Questionnaire for Respondents

Dear Respondent

The purpose of this questionnaire is to gather information which will be used for study on the Effect of small scale Irrigation on household food security in Bona zuria woreda. This study is going to be conduct for the partial fulfillment of MSc degree in Rural Development at Hawassa University. You full support and willingness' to respond to the question is very essential for the success of the study. Therefore, you are kindly requested to answer all questions and give clear, appropriate and reliable information on the issues. Be sure that the information you provide is only for the purpose of this study. Thanks you.

Date of interview (dd/mm/yy) _____ / _____ / _____

Kebele: - _____

Name of interviewer: - _____ Signature _____

Participant status: 1. Participate in irrigation 0. Non participate in irrigation

Section one

Objective three:-To identify the determinant factors that affects the household food security.

Demographic characteristics

1. Household head's Name: _____ Sex: 1= Male, 2= Female

2. Household ID ----------

3. Household Characteristics: Please list *all* household member

HH member ID	3.1 Name	3.2 Sex[1]	3.3 Age (in months)	3.4 Marital status[2] (> 14 yrs)	3.5 Relation to the head[3]	3.6 Religion[4]	3.7 Education status[8] (> 7 yrs)	3.8 Income source (> 15 yrs) (P= primary, S=secondary)		3.9 Skill[7] (> 15 yrs)	3.10 Ethnicity[8]	3.11 Presence[9]	3.12 Reasons for absence[10]
								P	S				
001													
002													
003													
004													
005													
006													
007													
008													
009													
010													

CODES FOR HOUSEHOLD CHARACTERISTICS:

[1] Sex:	[2] Marital status	[3] Relationship to head of household (HH)	[4] Religion	[5] Educational status
1=Male	1= single	1=Household head(HH)	1= Orthodox	1=Illiterate
2=Female	2=married	2=Spouse	2= Islam	2=Church/mosque education
	3=divorced	3=Son	3=Catholic	3=Adult literacy prog
	4=widowed	4=Daughter	4=Protestant	4=Elementary school
	5=separated	5=Brother or sister	5=Other	5=Junior complete
	6=other (specify)	6=Mother/Father		6= 10 complete
		7=In-laws		7= 12 complete
		8=Relatives		8= College graduate
		9= Hired helper		9= Other (specify)
		10=Other (specify)		

[6] Income source (P= Primary, S= Secondary)	[7]Special skill	[8]Ethnicity	[9]Presence	[10]Reason for absence
1=Farming	0= No special skill	1=Amhara	Number of months during 2006 E.C. (0-12 months)	1=Visiting family
2=Civil Servant	1=Mason	2=Tigraway		2=Away for school
3=Housewife	2=Trader/merchant	3=Oromo		3= Away for work
4=Daily laborer	3=Handicraft	4= SPNN		4=Looking for work
5=PA/village official	4=Carpenter	5= Other (specify)		5=Health treatment
6=Hand craft	5=Traditional healer			6=Other (specify)
7=Herder	6=Other (specify)			
8=Stone/sand mining and sale				
9=Trader				
10. =Other (specify				

4. Household land holding and crop production

Parcel	Plot	4.1. Area (in timad/koti)	4.2. Distance from home (in	4.3. Slope of the plot (see code)	4.4. Soil depth condition (see code)	4.5. Degree of erosivity (see code)	4.6. Irrigated land1=yes, 2= no	4.7. Land tenure system (use code)	4.8.Crop type grown 2006/07 season	4.9. If not cultivated the typical land use (use code)not cultivated, explain the reason (see code)	4.10. What is the main reason for not cultivating (use code)	4.11. Household/hired labor used for plowing (units)		4.12. Household /hired labor for cultivation (units)		4.13. Household /hired labor used		4.14.Average price for labor man days (LMD)	
1												F	M	F	M	F	M	F	M
	1																		
	2																		
2	1																		
	2																		
	3																		
3	1																		
	2																		
	3																		

4.3. Slope 1= flat, 2= slight slope, 3= moderate slope, 4= steep slope

4.4. Soil depth code: 1= shallow, 2= medium, 3= deep

4.5 Erosion severity: 1=No erosion, 2= Less erosion; 3=Medium erosion; 4= High erosion;

5= extremely eroded, 6= other (specify)

4.7. Land tenure code: 1= own land, 2= rented-in, 3= rented out, 4= other (specify)

4.8. Crops: 1= teff, 2= wheat, 3= barley, 4= maize, 5= millet, 6= sorghum, 7= Enset, 8=Faba bean 9 =field pea, 10=cheak pea, 11= Sorghum, 12== haricot bean, 13 = Vegetables and tubers, 14= Fruit trees (specify), 15= Fallowing 16= other (specify).

4.9. Land use code: 1= restricted grazing, 2= non restricted grazing, 3= forest/woodlot, 4= Bush/shrubs, 5= other (specify)

4.10. Reasons code: 1-fertility decline /for fallowing purpose, 2=lack of oxen for cultivation, 3=unable to afford fertilizer inputs, 4=Others,(specify

Fertilizer use, crop management and output

Parcel	Plot	4.15Oxen days for plowing/ cultivation	4.16 Oxen day price/day	4.17 seed type 1= local, 2= improved	4.18 Seed qty (in KG)	4.19 Seed price Birr/kg	4.20 Source of seed	4.21 Use organic fertilizer 1= yes, 0= No. If No skip to 4.24		4.22Source of manure/compost (Use code)	4.23Input source for compost making	4.24 Use inorganic fertilizer 1= yes, 0= No. If No skip to	4.25 Amount of Fertilizer (DAP, UREA, etc.) used (in KG)		4.26 Price of fertilizer (in Birr/kg)	4.27 Source of fertilizer (Use code)	
1								M	C				D	U	D	U	
	1																
	2																
2	1																
	2																
	3																
3	1																
	2																
	3																

4.20. Source code: 1= Own, 2= Neighbor, 3= Open market, 4= Cooperatives/union, 5= Service cooperatives, 6= other (specify)

4.21 M= manure, C= compost

4.22=own, 2=neighbor

4.23. Compost making code: 1=crop residues (specify), 2= tree leaves (specify), 3= animal dung, 4=Combination of these inputs, 5= other (specify)'

4.25 D= Dap, U= UR4.27. Source of fertilizer code: 1= Neighbor, 2= Open market, 3= Cooperatives/union, 4=Service cooperative 5. Other (specify)

Household ID ----------

(Continued …**)**

Parcel	Plot	4.28 Used pesticide/insecticide 1= yes, 0= No. If No skip to	4.29 Amount of pesticide used (in KG)	4.30 Price of pesticide (in Birr)/kg	4.31 Amount of insecticide (in	4.32 Price of insecticide (in Birr/ltr)	4.33 Source of	4.34 Other expenses (in Birr)	4.35 Total output quantity (Kg)	4.36.Quantity sold (in Kg)	4.37 Sell price/kg	4.38 Place of sell (see code)	4.39 Sold to whom (see code)	4.40 Distance to the major market (in km)	4.41 Mode of transport	4.42 Transport cost (in Birr)	4.43Freight cost (Birr/ Kg)
1																	
	1																
	2																
2	1																
	2																
	3																
3	1																
	2																
	3																

4.33 Source of insecticide/pesticide code: 1= Neighbor, 2= Open market, 3= Cooperatives/union, 4= Service cooperatives, 5= others

4.38. Market place: 1= farm gate, 2= market in the PA, 3= Market in the district capital, 4= Market at zonal capital, 5= Market at the regional capital, 6= other, (specify)

4.39. Market actors: 1= Farmers, 2= Assembler/broker, 3= Wholesalers, 4= Retailer, 5= Service cooperatives/union, 6= Consumers, 7= Other,(specify

Livestock holding

5. Does Place of sell (see code) your household own livestock? 1. Yes 0.No

5.1. If yes to Q. xxx, give details on the table below

Type of Livestock	Number owned during last year	Number of livestock died during last year	Number of livestock bought during last year	Number of livestock sold during last year	Total value(Birr)

Codes: 1. No Livestock 2.Oxen 3.Cows 4. Calves 5. Heifers 6.Sheep

7. Goats 8. Chicken 9.Horse 10.Mule 11.Donkey 12.Camel 13.Others

Health-related factors

6. If anybody in your household is sick? 1. Yes 2.No6.1. Which of the following places do you first contact for a solution? 1. Clinic/Hospital 2.Dispensary 3.Traditional healer 4.Spiritualists 5. Others, specify

6.2. What is the distance between your house and clinic or hospital _____km?

Institutional factor

Access to credit

7. Have you over the last 3 years received credit for?

Non-agricultural Investments	Yes	No	Amount	Source
Consumption loans	Yes	No		
Family events	Yes	No		
Other, specify	Yes	No		

7. 1. If you want, are you able to obtain credit for?

Purpose	Yes/No	Source	Max amount	Interest	Duration	Finish repayment
a. Investment						
In farm inputs						
In oxen purchase						
In other business						
b. Consumption						
c. Family event						

Code: 1. Bank, 2= microfinance institution, 3. Neighbor/relatives, 4. Association/equip, 5.others

Physical factors

Agricultural Extension

8. Is there farmers training center (FTC) in your kebele? 1. Yes 2. No

8.1. If yes, how far is the FTC from your home _____ in Km?

8.2. Do you contact with DA/ Development agent? 1. Yes 2. N

8.3. If yes when you contact with DA per month? 1. One times 2.Two times 3.More than two times

Use of small scale irrigation

9. How many times do you produce per year using irrigation? _____

9.1. Have you ever faced a problem of crop failure while you are using irrigation?

1. Yes 0. No

9.2. If your answer for question number 9.1 is yes, what were the possible causes for this problem of crop failure last year? 1. Water shortage 2. Damaged by disease 3.Poor adaptation of varieties used 4. Poor administration of water distribution 5.Others, specify

9.3. What is the source of water for your irrigation? 1. Rivers 2. Springs

3. Ponds 4. Well 5. Other, specify _____

9.4. How much the distance between the sources of water to your irrigated land? ___ (in km).

9.5. If no use irrigation, why not you use irrigation technology? 1. Distance of water to farm land 2.Lack of farm land 3. Cost of irrigation materials 4. Overall cost of technology

10. Are you supported by Livestock and Irrigation value chains for Ethiopian smallholders (LIVES) project? 0. No 1. Yes

10.1. If the answer is yes to Q. xxx, what benefits did you get from this project? 1. Exposure for improved technology 2. Exposure for improved practices (practical lessons)

3. Demonstration to applicable technologies 4. Market networking, 5.Production and post-production advice, 6. Other, specify

10.2. Is there any change on household food security and production after the support by LIVES project? 0. No 1. Yes

10.3. If the answer is yes to Q. xxx, what is the change? 1. Improved household food security 2. Increase the productivity 3. Create opportunity for non- employment 4. Reduced dependency

11. Off/non-farm income

Now I will ask you about whether you participated in non-farm employment and earned some income in 2006. [Please first ask type of employment and then the rest].

Source	11.1 Who earned (HH member ID)	11.2 # of months/days per yrs.	11.3 Quantity	11.7 Wage (cash) in Birr	11.8 Wage (kind) in Birr	11.9 Total Income (= wage or price (in Birr) x quantity or #days or months)
Food for Work						
Cash for work						
Hire out labor						
Part time job						
Remittance income						
Food aid						
Self-employment						
Sale of Firewood						
Sale of Handicraft						
Sale of beverages						

Chat trading						
Other petty trade						
Village shop						

***Unit:** Kg, Liters, Koti, Timad, etc

Food Aid

12. Have you received any aid in the last year? 1. Yes 0. No

12.1. If yes to question 12, please indicate the type and amount receive

Type of aid items received	Amount of Aid Received per month	Unit price	Total income received
Total			

Code: 1.Wheat 2.Cash 3.Oil 4.Other

Section two:-

Objective two:-factors constraining irrigation use

13**.** What are the major problems/factors constraining irrigation use/ in your area?

1. Distance from water source to farm land2.Lack of effective marketing system 3.Lack of input supply and irrigation facilities 4.Presence of pests and diseases 5Lack of irrigable land6.Others/specify_____

Section three:-

Objective one: - To compare the household food security of irrigation users and non- user

14. Household livelihoods

Instruction: Please ask the questions preferably to the mother or the care giver. There are of course few questions which need to be asked to the husband as well. If there is no mother in the household, ask the husband or any adult.

14.1. Number of food servings per day [First check the composition of the household members in the household]

Household members	Tick	Number/frequency of meals
Children under five		
Adolescent girls (10-19 years)		
Adolescent boys (10-19 years)		
Lactating mother		
Pregnant mother		
Non lactating /non pregnant mother		
Husband		

Code: 1= Once, 2= Twice, 3= Three times, 4= More than three times

14.2. Did your household face food shortages in the last 5 years?

1= Yes 0= No [If no skip to 13.5]

14.3. If yes to Q. 14.2, how often has the household faced food shortages? _____

1= Sometimes (once in 5 years), 2= Often (2-3 times in 5 years), 3= Very often (3-4 times in 5 years), 4= Always (continuous/chronic problem)

14.4. When is food shortage more serious in the household? _____

1= Kiremt (June to August). 2= Meher (Sept. to November), 3= Bega (December to February), 4= Tseday (March to May)

14.5. If yes to Q. 14.2 how does food shortage affect household consumption? Rank 1 to 4

Code: 1. Never, 2. Rarely (once), 3. From time to time (2 or 3 times) 4. Often (5 or more times) if there is change as a result of food shortage

In the last seven days

Effects	14.5.1 Overall Rank for Household	14..5.2 Under 5 Children	Adolescent (10 – 19 years)		Adult (> = 20 years)	
			14.5.3 Girls	14.5.4 Boys	14..5.5 Female/ Mothers	14..5.6 Male/ Father
Consumed less preferred foods						
Reduction in number of meals						
Reduction in the quantity of food at each meal						
Skipped meals						
Skipped meals for a whole day						
Reduction in the quality of food taken						
Reduction in complementary foods to children						
No change						

Appendix IV: Household food security Questionnaires

Household Food Insecurity Access Scale (HFIAS) Measurement Tool

15. For each of the following questions, think about what happened over the past 30 days. Please answer if this has "ever" happened yes or no, if No, go to the next main question; if yes, answer the sub question is rarely (only one or two times over the past month), « sometimes », (every now and then during the past month) or "often" (almost every day), indicate the answers in the table below.

No	Question	Response options	Code
1	In the past four weeks, did you worry that your household would not have enough food	0 .No (skip to Q2) 1.Yes	0 /__ / 1 /__ /
1a	How often did this happen?	1 .Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack resources?	0. No (skip to Q3) 1.Yes	0 /__ / 1 /__ /
2a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to lack resources?	0 = No (skip to Q4) 1 .Yes	0 /__ / 1 /__ /
3a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of	0. No (skip to Q5)	0 /__ /

	a lack of resources to obtain other types of food?	1.Yes	1/__ /
4a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	0 /__ / 1/__ /
5a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0. No (skip to Q7) 1. Yes	0 /__ / 1 /__/
6a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2.Sometimes (three to ten times in the past four weeks) 3.Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0. No (skip to Q8) 1. Yes	0 /__ / 1 /__/
7a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0. No (skip to Q9) 1. Ye	0 /__ / 1 /__/

8a	How often did this happen food?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3.Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /
9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough	0. No (questionnaire is finished) 1. Yes	0 /__ / 1 /__/
9a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	1 /__ / 2 /__ / 3 /__ /

Section four

Objective four: - To determine whether diet diversity between irrigators and non-irrigators are different

16. Household dietary diversity (HDD) score questionnaire

NO	Food items	YES=1 NO=0
1	Any Bread or any other foods made from wheat, sorghum, and maize, Barely, e.g. Beso, Kolo, porridge, enjera or other locally available grains.	
2	Any potatoes, enset, or any other foods made from roots or tubers?	
3	Any vegetables?	
4	Any fruits?	
5	Any beef, lamb, goat, wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	
6	Any eggs?	
7	Any fresh or dried fish or shellfish?	
8	Any foods made from Beans, peas, cowpeas, pigeon peas nuts, haricot bean, chick bean seeds?	
9	Any cheese, yogurt, milk or other milk products?	
10	Any food made with oil, fat, or butter	
11	Any sugar or honey?	
12	Any other foods, such as condiments, coffee, tea?	

17. Household Food Consumption

Food groups	Food item	How many days in the past one week your household has eaten							
		No eat	1	2	3	4	5	6	7
Cereals	Any Bread or any other foods made from wheat, sorghum, and maize, Barely, e.g. Beso, Kolo, porridge, enjera or other locally available grains.								
Tubers/ Root	Any potatoes, enset, or any other foods made from roots or tubers?								
vegetables	Dark green vegetable – leafy								
Fruit	Fruits								
Meat and fish	Any beef, lamb, goat, chicken, liver, kidney, heart, or other organ meats								
	Eggs								
	Any fresh or dried fish or shellfish								
Pulses	Any foods made from Beans, peas, cowpeas, pigeon peas nuts, haricot bean, chick bean seeds?								
Milk/ Milk Products	Any cheese, yogurt, milk or other milk products								
Oil/fat	Any food made with oil, fat, or butter								
Sugar	Any sugar or honey								

I. Checklist for focus group discussion

1. Is there a shortage of availability of food in your kebele in the past 12 months? If yes, in which year or month this problem face to you and what did your measurement at that time or how did you solve this problem?

2. What is your general opinion on the role of small scale to household irrigation on household food security?

3. What are the determinant factors do affect your household food security?

4. What are the major factors constraining irrigation activities in your area?

5. Which do you prefer irrigated agriculture or rain fed agriculture? Why?

6. Is there any difference food security status between irrigator and non-irrigator? What is the difference between these two groups?

7. Is there any difference diet diversity between irrigator and non-irrigator? What is the difference?

8. Is there equal right to use irrigation water in your area?

II. Questions Used to Key Informants interview (KII)

1. What are the major factors constraining irrigation activities in your area?

2. Is the any difference food security status between irrigators and non-irrigators?

3. If yes, what are the main differences between these two groups?

4. What are the major determinant factors that affect the household food security?

Appendix V: Independent Sample Test Result of Continuous Variables

		Levine's Test for Equality of Variances		t-test for Equality of means	
		t	Df	Sig. (2-tailed)	Mean Difference
Age of household	Equal variances assumed	-4.002	198	.000	-5.685
	Equal variances not assumed	-4.049	152.412	.000	-5.685
Family labor	Equal variances assumed	2.756	198	.006	.58056
	Equal variances not assumed	2.977**	181.415	.003	.58056
Dependency ratio	Equal variances assumed	-6.316	198	.000	-.424336
	Equal variances not assumed	-5.302***	90.398	.000	-.42436
Land holding size	Equal variances assumed	11.181	198	.000	.57764
	Equal variances not assumed	12.183**	184.822	.000	.57764
Livestock holding in TLU	Equal variances assumed	2.284	198	.023	.55250
	Equal variances not assumed	2.282	146.979	.024	.55250
Market distance	Equal variances assumed	1.129	198	.260	.20677
	Equal variances not assumed	1.121	144.350	.264	.20677

** and *** represent at 5% and 1% significant level respectively.

Source: Survey result (2016).

Appendix VI: The Chi-square Result of Dummy Variables

Dummy variables	Pearson Chi-Square or Fisher's Exact Test	df	P-value
1.Sex of respondents	6.664***	1	.010
2.Education level of .respondent	43.862***	5	0.000
3. Access to irrigation	28.125***	1	0.000
4.Access to credit	0.007	1	0.934
5.Nonfarm activity	4.056**	1	0.044
6.Health status of respondent	0.066	1	0.797
7.Number of contact with DA per month	1.614	1	0.204
8.Received food aid	9.599***	1	0.002

and * represents at 5% and 1% significant level respectively.

Source: Survey result (2016).