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DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

The Impact of Small-Scale Irrigation on Household Food Security in Drought Prone Area of Wag Himra Zone: The Case of Abergelle Woreda

BY:

Girmay Tumay

AUGUST 2020

DESSIE, ETHIOPIA

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (M.Sc) IN GEOGRAPHY AND ENVIRONMENTAL STUDIES (SPECIALIZATION IN SUSTAINABLE NATURAL RESOURCE MANAGEMENT)

ADVISOR: Goitom Sisay (PhD)

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APPROVAL SHEET

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As a member of the Examining Board of the Final MSc Open Defense, we certify that we have read and evaluated the Thesis prepared by Girmay Tumay and Entitled" THE IMPACT OF SMALL SCALE IRRIGATION ON HOUSEHOLD FOOD SECURITY IN DROUGHT PRONE AREA OF WAGHMRA ZONE: THE CASE OF ABERGELLE WOREDA and recommended that it be accepted as fulfilling the thesis requirement for the degree of master of art in Geography and Environmental studies.

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Name of major advisor	signature	Date
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Name of Co - advisor	signature	Date
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DECLARATION

I, the undersigned, have by declaration that I have completed research thesis on "The Impact of Small-Scale Irrigation on Household Food Security in Drought Prone Area of Wag Himera Zone: The Case of Abergelle Woreda" as part of the course requirement.

I further declare that this study is my original work and that information presented is true. The matter embodies in this report has not been submitted earlier for the award of any degree or diploma to the best my knowledge and belief.

Declared by:

Name Girmay Tumay

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CERTIFICATION

This is to certify that Girmay Tumay has carried out his research work on the topic entitled "The Impact of Small-Scale Irrigation on Household Food Security in Drought Prone Area of Wag Himera Zone: The Case of Abergelle Woreda". The paper is original in nature and it is suitable for submission for the reward of MSc degree in Sustainable Natural Resource Management.

Goitom Sisay

(PhD) _____ _____

Advisor **Signature** **Date**

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Acronyms and Abbreviations

AD	Development Agent
ADLI	Agricultural Development Led Industrialization
AWOA	Abergelle Woreda Agricultural Office
CIA	Conditional Independency Assumption
CSA	Central Statistics Agency
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
FCS	Food Consumption Score
FDRE	Federal Democratic Republic Government of Ethiopia
GDP	Gross Domestic Product
HDD	Household Dietary Diversity
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institutes
JEOP	Joint emergency operation plan
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
PSNP	productive Safety net program
SPSS	Statistical Package for Social Sciences
TLU	Tropical Livestock Unit

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Abstract

Ethiopian agriculture is largely small-scale subsistence oriented and crucially dependent on rainfall with very low productivity. Small-scale irrigation is believed in helping to address food gap there by 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 analyze the impact of small-scale irrigation (SSI) on household food security in Abergelle woreda, Wag Himra zone of Amhara National Regional State (ANRS). The research design employed by the researcher was descriptive survey research design. Moreover, qualitative and quantitative research approach was employed. The primary and secondary data were collected using Questionnaire, focus group discussion, key informant and by reviewing different documents to achieve the objectives of the study. Meanwhile, stratified random sampling technique was employed based on the nature of the target population. Then 332 sample households were selected both from irrigation user and non-user households. To analyze the collected data, both descriptive (mean, standard deviation) and inferential (binary logistic regression) methods were employed. The descriptive statistics result revealed that 88% of the users and 57.2% of non-users are found to be food secure while only 12% of users and 46.8% of non-users are found to be food insecure. The econometric model result indicates that, age of the household head, education level of household head, cultivated land holding, access to irrigation were the major factors that significantly and positively influence household's food security status. On the other hand, Dependency ratio and access to functional irrigation negatively and significantly affected household food security situation. The study concluded that small scale irrigation is one of the practicable solutions to secure household food needs and diversify their diet composition in the study area. Finally, it is recommended that coupled with the identified determinants of household food security governmental and non-governmental organization should give due attention to expand access to small-scale irrigation (SSI) for farm households to improve their food security status.

Key Words: *Diet diversity, Food Security, irrigation non-users, irrigation users, Small Scale Irrigation*

CHAPTER ONE
INTRODUCTION

1. Introduction

1.1. Background of the Study

Irrigation is an age-old art. It was practiced for thousands of years in the Nile Valley. Egypt claims to have the world's oldest dam built about 5000 years ago to supply drinking water and for irrigation. At that time basin irrigation was introduced and still plays a significant role in Egyptian agriculture. According to Zewdie et al. (2007) irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. India and Far East have grown rice using irrigation nearly for 5000 years. The Nile valley in Egypt, the plain of Euphrates and Tigris in Iraq were under irrigation for 4000 years. Irrigation is the foundation of civilization in numerous regions. Egyptians have depended on Nile's flooding for irrigation continuously for a long period of time on a large scale. The land between Euphrates and Tigris, Mesopotamia, was the breadbasket for the Sumerian Empire. The civilization developed from centrally controlled irrigation system (Getaneh, 2011).

In Ethiopia, modern irrigation began in the 1950s through private and government owned schemes in the middle Awash valley where big sugar, fruit and cotton state farms are found (FAO 1997). Furthermore, there has been a revival of irrigation during the last decades in order to enhance rural development and food security in Ethiopia (FAO/WFP, 2006). Given that 85 percent of the people are employed in agriculture (Mengistu, 2003), developing this sector could help to reduce poverty and enhance food security of most of the Ethiopian people (Hagos, 2007). One of the main targets of irrigation systems is to fortunate agricultural production in qualitative as well as in quantitative meaning (Mengistu, 2003). Harvests shall be enlarged so that people either produce enough food for the non-harvest time or to sell their overproduction and earn some money to buy food. Another opportunity to produce more food crops is irrigated gardening, an activity mainly done by women.

Agriculture is the backbone of the Ethiopian economy as it accounts for about 80% of the population directly or indirectly involved in it. This implies that it is the dominant sector for GDP contribution. For example, in 2011, agriculture contributed to national GDP (40%),

employment (80%), supply of raw materials (70%), government tax revenue (28%) and export earnings (85%). However, because of small and fragmented landholding, dependence on natural factors of production, environmental degradation, population growth, low access to new agricultural technologies, traditional methods of cultivation, and low institutional support services, it is largely based on subsistence farming (MoFED, 2012). In history, Ethiopia is characterized by famine because of high population pressure, resource base depletion and drought that affects the rain-fed agriculture significantly (Berhanu, 2001; Bruce et al., 1994). One of the features of the Ethiopian agriculture and the national economy at large is its inability to produce sufficient food to feed the population (Samuel, 2006). It has been documented that low farm production and productivity resulting from use of backward technology and other productivity-enhancing modern inputs are the major reasons for rampant poverty and food insecurity in rural areas (FDRE, 2010; Samuel, 2006).

To this end efforts have been made to implement strategies to improve productivity of smallholder farmers by disseminating effective technologies through the scaling up strategy, to conserve natural resources and improve irrigations, and to bring about a shift from subsistence agriculture to production of high value agricultural products (FDRE, 2016). Consensus has been reached by the government and donors that any solution to further reduces rural poverty must focus on increasing the production and productivity of smallholder agriculture (FDRE, 2010). Creating access to fertilizer, improved seeds, agricultural credit and thereby bringing significant growth in crop production is the major concern of national strategy (Samuel, 2006).

To address subsistence farming problem, the government of Ethiopia designed a national strategic plan in 2010/1, Growth and Transformation plans (GTP 1 and GTP 2). Agriculture will remain throughout the two GTPs years as main driver of the rapid and inclusive economic growth and development. It is also expected to be the main source of growth for the modern productive sectors. Therefore, besides promoting the productivity and quality of staple food crops production, special attention will also be given to high value crops, industrial inputs and export commodities. To this end irrigation based agriculture, horticulture, fruits and vegetables, livestock and fisheries development will be promoted. Designing and providing support schemes to small holder farmers where peasants and pastoralists are the main actors in the production process; and facilitating a joint participation of educated young farmers and private investors in

the sector are strategic directions that will be pursued during the plan period. To this end, addressing constraints entrenched in the agricultural development and marketing systems will be given utmost emphasis and priority.

Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation, food security and growth. It enables households to generate more income, increase their resilience, and in some cases transform their livelihoods (MOFED, 2006).

Ethiopia is believed to have the potential of 5.1 million hectares of land that can be developed for irrigation through pump, gravity, pressure, underground water, water harvesting and other mechanisms (MOFED 2010). According to BOARD (2010) and Awulachew et al. (2005) report the total irrigated land in the Amhara region was 347,725 hectares. There are 310 modern irrigation schemes developed in this region. The irrigation schemes developed have covered an irrigated area of 8,469.2 hectares with 17,443 beneficiaries. Out of these total irrigated areas 5,718.68 hectares is for small-scale and 2,750.58 hectares is for medium-scale irrigation schemes. Moreover, the study area, Wag Himra zone has a total irrigation potential of 3435 ha from this, about 2675 ha is currently under utilization and there is total a beneficiary of 18,525 farmers.

According to Wag Himra Agricultural Office (2019), small-scale irrigation is being practiced in the study area since 1995. Aware of this fact, farmers in Abergelle 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. Therefore, this study is aimed to analyze the impact of small-scale irrigation on household food security in the study area.

1.2. Statement of the Problem

Ethiopia is one of the most impoverished countries of the world. A large portion of the country's population has been affected by chronic and transitory food insecurity. The situation of chronically food insecure people is more and more severe. Food security situation in Ethiopia is highly linked up to severe, recurring food shortage and famine, which are associated to recurrent drought (MoARD, 2010).

To put in perspective, according to WFP (2019), over 20 million chronically food insecure households living in 300 Woredas has been targeted in Productive Safety Net program (PSNP) and Joint Emergency Operation plan (JEOP) to get a food support for the coming five years at national level. Likewise, about 7.2 million households in Amhara National Regional State (ANRS) has been planned to supply to 712800 tons of food commodities under the ongoing program (WFP, 2019). This food insecurity situation is resulted because of natural and manmade factors mainly drought, land degradation, population pressure and lack of infrastructure facilities (FAO/WF, 2019). In the same manner, over one third of Ethiopia's Woredas (districts) were officially classified as facing a dire food security and nutrition crisis over the year. At the peak of the crisis in April, more than 10.2 million people were targeted with life-saving food assistance, while an additional 7.9 million people were targeted through the Productive Safety Net Program (PSNP). The most affected regions included Afar, Amhara, Dire Dawa, Harari, Oromia, SNNPR, Somali and Tigray (OCHA, 2016).

In the meantime, Abergelle Woreda is highly affected with drought and its farming system is traditional rain feed beyond this, the summer rain does not start on time and leave early. Currently from the total population of the woreda about 37,302 are food insecure and supported by Development Food Security Aid (DFSA) and Joint Emergency Operation Plan programs (JEOP). As response to this problem, small scale irrigation in the woreda has been practiced in the study area since 2010. Currently, about 419.64 ha were under cultivated (WOARDO, 2019).

In Ethiopia, though the country is known for its drought and famine worldwide, the impact of small-scale irrigation on household food security is yet under study. Though there is no consensus among various empirical studies on the impact of irrigation; many scientific studies have been conducted to unveil the impact of irrigation on household food security. For instance, Getaneh (2011) *The Impact of Selected Small-Scale Irrigation Schemes on Household Income and the Likelihood of Poverty in the Lake Tana Basin of Ethiopia* have attempted to uncover the major field crops and vegetables grown, compare the relative advantages of the various types of small-scale irrigation system and examine the major constraints encountered in the use of the small-scale irrigation systems in the study area.

Similarly, Lemma (2004) in his study Smallholders' Irrigation Practices and Issues of Community Management: *The Case of Two Irrigation Systems in Eastern Oromia*, noted the contribution of irrigation practices in households' income, assess the role of irrigation practices in improving household's food security and assess the problems encountered in irrigated agriculture. Moreover, Muez (2014) in his study entitled: *The Impact of Small-Scale Irrigation on Rural Household Food Security, the case of Emba Alaje woreda*, showed the main economic factors that influence farmers to participate in small-scale irrigation and food consumption expenditure and examine the economic impact of small-scale irrigation on household farm income and food security.

Though the above studies conducted in different places in Ethiopia, but they are not far from limitations such as applying variety of measurement of household food security and the segmentation of their study population into irrigation users and non-users. They didn't include male and female headed irrigation users and non-users which are very important indicators of food security variation among the study population other than irrigation user and non-user. This implies that analysis of the above studies had limitations simply because they used poor measurements. Furthermore, in Abergelle woreda it is not well known to what extent the households that are using irrigation are better off than that of non-users. The effect of small-scale irrigation on household food security is also not yet well studied in the study area.

Therefore, given the disparity in methodology and lack of well-studied researches in the study area the researcher was motivated to undertake the study. Besides, this research also attempted to unveil how much the irrigation scheme enables irrigation users to satisfy their food gap in contrast to non-users.

1.3. Objective of the Study

1.3.1. General Objective

The general objective of the study was to analyse the impact of small-scale irrigation (SSI) on household food security in Abergelle woreda, Wag Himra zone of Amhara National Regional State (ANRS).

1.3.2. Specific Objectives

This study specifically aims to:

- To compare food security situation of irrigation user and non-user households in the study area.
- To examine food consumption pattern between irrigator and non-irrigator households in the study area.
- To analyze diet diversity between irrigator and non-irrigator households in the study area.
- To identify the determinant factors that affects the household food security in the study area.

1.4. Research questions

This research tried to answer the following four basic questions:

- Is there any food security situation difference among irrigators and non-irrigators?
- Is household food consumption pattern of differ between irrigation users and none irrigation users?
- Is diet diversity of household's differ between irrigation users and none irrigation users?
- What are the determinant factors that affect household food security?

1.5. Significance of the study

Understanding the impact of small-scale irrigation on food security in drought prone areas will have a premium importance for both scientific engagement of the practices and serves the concerned sector offices and other stakeholders to be able to have the necessary baseline data to design projects and strategies to enhance the knowledge of the community on irrigation in the study area. Therefore, this study will have the following relevance:

- Enable the Woreda food security office to manage effectively the irrigation scheme;
- It will broaden the existing knowledge in the area to concerned bodies.
- It may pave the way for further work and help as a reference material for other researchers.

1.6. Delimitation (scope) of the study

Delimitation of the research is generally two types: content delimitation and areal delimitation. Content wise; the scope of the study was to assess the impact of small-scale irrigation on household food security and geographically it was confined to Abergelle woreda kebele 01 & 05.

1.7. Limitation of the study

Limitation of the research is associated with problems encounter while the study was conducted. The major factors that affect the research among others were inability to gain adequate fund to undertaken extensive household (HH) survey and 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 forced to walk longer distance on foot. This made the data collection process longer than it was planned.

1.8. Organization of the Paper

This paper is divided into five chapters. The first chapter provides an overview of the study. It contains general introduction to the issues with which the study is concerned, back ground of the study, problem statement, objectives and research questions, significance of study, scope of study, limitations and organization of the study. The second chapter assesses previous literature and studies relevant to the fields and related topics. The third chapter describes and explains the research methodology that was used in the study. Chapter four includes data presentation, analysis and interpretation, and finally in Chapter five conclusions, recommendations and direction for future research is presented.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This section carefully reviews scholarly literature on concept, type and method of irrigation and its determinant factors that affect the adoption of small-scale irrigation. It provides an extensive and sufficient guide for the research.

2.1. 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.

2.2. Irrigation techniques/ methods

Irrigation methods are system how to obtain water for irrigation purposes from its sources. It depends on water resources, water rules, rain water, topography, plants cultivated and growing seasons Dupriez and De Leener (2002). There are two general methods of applying irrigation water. These are surface irrigation and Sub-surface irrigation.

2.2.1 Surface irrigation

Surface irrigations are the oldest methods of irrigation, which convey water from the survey to the fields in lined or unlined channels. Surface irrigation is the introduction and distribution of water in a field by the gravity flow of water over the soil surface. The primary methods of applying water are Basins irrigation, Boarders irrigation, Flood irrigation and Furrows irrigation Widtose (2001). One can choose these irrigation methods depending on the nature of the soil, the form of the land, the head of the water stream, the quantity of water available and the nature of the crop. Since the method used in the study area is related with surface irrigation the discussion below is related with this.

2.2.1.1. Basin irrigation

Basin irrigation is the most common form of surface irrigation, particularly in regions with layouts of small fields. A basin is a piece of land, small or large, surrounded by earth bunds in which water is pounded. The field to be irrigated is divided in two units surrounded by levels or dams. Gated outlets, siphon tubes, spiels, and hydrants conduct water from delivery channels in to each basin. This type of irrigation is suitable for all types of soil and efficient use of water, but it needs high initial cost for leveling land.

2.2.1.2. Furrow irrigation

Furrow irrigation is accomplished by running water in small channels that are constructed with or across the slope of a field. Furrow irrigation avoids flooding the entire field surface by channeling the flow along the primary direction of the field using 'furrows,' 'creases,' or 'corrugations. Water infiltrates through the wetted perimeter and spreads vertically and horizontally to refill the soil reservoir. Water is diverted in to furrows from open ditches or pipes. The advantage of this type of irrigation are Uniform application of water, less evaporation loses, less intercultural operations but it needs high cost for preparing furrows. Because it requires more and require more labor

2.2.1.3. Border irrigation

Border irrigation is an open-field method viewed as an extension of basin irrigation to sloping, long rectangular or contoured field shapes, with free draining conditions at the lower end. Here a field is divided into sloping borders. Water is applied to individual borders from small hand-dug checks from the field head ditch. Soils can be efficiently irrigated which have moderately low to

moderately high intake rates but, as with basins, should not form dense crusts unless provisions are made to furrow, or construct raised borders for the crops. The benefits of this type of irrigation are uniform application of water, uniform application of water, efficient use of water but it requires repairing of ridges and supervision during irrigation and land needs to be graded uniformly

2.2.1.4. Flood irrigation

Flood irrigation is an ancient method of irrigating crops. It was likely the first form of irrigation used by humans as they began cultivating crops and is still one of the most commonly used methods of irrigation used today. Water is delivered to the field by ditch, pipe, or some other means and simply flows over the ground through the crop. This type of irrigation is least cost method and does not require any skill, but it is inefficient method, result in uniform stand of crops and low yield, and more wastage water due to run off, deep seepage and evaporation.

2.2.1.5. Drip irrigation

This method is one of the more advanced techniques being used today because, for certain crops, it is much more efficient than flood irrigation, where a larger portion of the water is lost to evaporation. Drip irrigation is practiced in dry, arid regions where water is scarce and must be used sparingly. Water is run through pipes (with holes in them) either buried or lying slightly above the ground next to the crops. Water slowly drips onto the crop roots and stems. The advantage of this type of irrigation are very economic, surface evaporation is reduced, sweated to arid regions and can be used for applying fertilizers, increases yield by 50-60%. But it needs high initial cost and maintenance.

2.2.1.6. Sprinkler irrigation

In this method of irrigation, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. According to Dupriez and De Leener (2002), Sprinkler irrigation imitates rainfall. It is also called overhead irrigation. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. In contrast to surface irrigation, sprinkler systems are designed to deliver water to the field without depending on the soil surface for water conveyance or distribution. This type of irrigation is beneficial for uniform distribution of water and highly efficient use of water, water application at controlled rate and used for cooling crops during high temperatures and frost

control during freezing temperatures. But it needs high initial costs and more maintenance, and there is high evaporation lose.

2.3. Irrigation Development in Ethiopia

Irrigation is one means by which agricultural production can be increased to meet the growing food demands in Ethiopia. Increasing food demand can be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land, and increasing cropping intensity (number of crops per year). Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristic of large parts of the country's land. Increasing yields in both rains fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are the most viable options for achieving food security in Ethiopia. If the problem is failure of production because of natural causes, such as dry-spells and droughts, agricultural production can be stabilized and increased by providing irrigation and retaining more rainwater for in situ utilization by plants.

Affording to Fuad (2002) irrigation in Ethiopia can be classified in to three. Those are Small-scale irrigations which are often community based and traditional methods covering less than 200hectares, medium scale irrigation which is community based or publicly sponsored, covering 200 to 3000 hectares and large-scale irrigation covering more than 3000 hectares, which is typically commercially or publicly sponsored.

Ethiopia has a long history of traditional irrigation systems. Simple river diversion still is the dominant irrigation system in Ethiopia. According to Gebremedhin and Peden (2002), the country's irrigation potential ranges from 1.0 to 3.5 million hectares but the recent studies indicate that the irrigation potential of the country is higher. According to Tilahun and Paulos (2004), estimates of the irrigation potential of Ethiopia may be as large as 4.3 million hectares. Traditional irrigation schemes cover more than 138,000 hectares whereas modern small-scale irrigation covers about 48,000 hectares. The total current irrigation covers only about 6% of the estimated potential land area. Irrigated agriculture is not an entirely new phenomenon in Ethiopia. As some literatures indicated, Small-scale traditional irrigation has been practiced for decades throughout the highlands where small farmers could be diverted seasonally for limited dry season cropping (FAO, 1994). According MoWE (2012) modern irrigation has 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 and it was strongly believed that rain fed agriculture should be supplemented by irrigation to achieve national food self-sufficiency and ensure household food security. The total irrigation potential in Ethiopia is 3,798,782 hectares but currently irrigation schemes have covered only 368,160 hectares, 10% of the potential (MoFED, 2012).

In the same way, (FAO, 2011) the Ministry of Water and Energy has identified 560 irrigation potential sites on the major river basins. The total potential irrigable land in Ethiopia is estimated to be around 3.7 million hectares (without considering the groundwater potential and gently sloping areas). The area under irrigation development to-date is estimated to range between 160,000 - 200,000 hectares for the entire country. Estimates of the irrigated area vary, but still is less than five percent of potentially irrigable land (Awulachew et al., 2007). Ethiopia has set itself an ambitious task to achieve an irrigation target of 1.8 million ha for irrigation development.

According to the MOA (2005) and Awulachew et al. (2007), Amhara region has 770,000 hectares of irrigation potential. Different development activities have been underway to utilize these resources. Currently, there are 310 irrigation schemes operating in the Amhara region. The irrigation schemes developed cover an irrigated area of 8,469 hectares with 17,443 beneficiaries. Of these total irrigated areas, 5,719 hectares are from small-scale and 2,751 are from medium-scale irrigation schemes.

According WFP (2010), in Ethiopia, due to the situations of people who do not have the capacity to produce or buy enough to meet their annual food needs even under normal weather and market conditions a total of 5.23 million people would need emergency food assistance from January to June 2010. The Productive Safety Net Program (PSNP) reach to support over 7.23 million people in 300 Woredas for seven regions (Tigray, Amhara, Oromiya, SNNPR, Afar, Harar and Dire Dawa) who are facing chronic food insecurity situation starting 2006. Hence, the expansion of small-scale irrigation schemes was taken as the main development strategy to reduce crop failure due to drought and erratic rain fall conditions in Ethiopia by preparing a National Medium-Term

Investment Program (NMTIP) for Water Sector Development Program (WSDP) for 15 years (2002-2016)

The major small scale irrigation problems identified include financial constraints especially for the purchase of motor pumps, shortage of agricultural inputs specially improved seed and pesticides, high cost of irrigation, shortage of water pump technologies, spare parts and gabions, technical problems such as maintenance of motor pumps, insufficient market information and market networks, shortage of ponds and diversion, infrastructure specially road and storage, theft of fruits, diseases and pests such as rust, root ruts, ball worm, blights, powdery mildew, gummosis and water borne diseases, inefficient management of resources such as water, land and labor. As per the discussion with wereda irrigation experts the major problems of the irrigation are shortage of motorized pumps, insufficient diversion infrastructure, shortage of improved seed, dependency syndrome on government and on donors (farmers want construction of diversion and water harvesting technologies from the government and donor) rather than introducing such irrigation schemes and technologies, inefficient utilization of resources such as water and land, lack of knowledge and skills in irrigation activities, inappropriate utilization of inputs and the likes.

2.4. An Overview of Ethiopia's Food Security Situation and Irrigation

According Seleshi et al, (2005), in Ethiopia those listed factors increasing population, deforestation and land distribution affected agricultural production. This reflected in a decrease in household production, grazing land. Hence, it has become a common phenomenon to ask for emergency food assistance for acutely food insecure people in Ethiopia.

Irrigation user households were more food secure than non-user's households 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 (Tizita Dantew, 2017).

Population increase, deforestation and frequent land distribution has affected agricultural production in Ethiopia. This is reflected in a decrease in household production, a decrease in

grazing land and scarcity of manure. That is why in most occasions; food insecurity quickly turns into famine when there are some climatic irregularities (Getinet, K.2011). Thus, it has become a common phenomenon to appeal for emergency food assistance for acutely food insecure people in Ethiopia.

According to FAO/WFP, (2010), a total of 5.23 million people would need emergency food assistance from January to June 2010. In addition, starting from 2006, the Productive Safety Net Programme (PSNP) reach to support over 7.23 million people in 300 Woredas for seven regions (Tigray, Amhara, Oromiya, SNNPR, Afar, Harar and Dire Dawa) who are facing chronic food insecurity situation as the same report disclosed by FAO/WFP explained. This is due to the circumstances of people who do not have the capacity to produce or buy enough to meet their annual food needs even under normal weather and market conditions.

Meanwhile, according to Lemma (2004) the major sources of household income in both schemes classified into four main groups that includes; income from grain production (rain fed and irrigated), income from cash crop production, income from sales of livestock and livestock products and income from non-farm sources. Small-scale irrigation in Ethiopia had a significant role in diversification of production to new types of marketable crops like fruits, cash crops and vegetables (Eshetu, 2010).

According to G/egziabher (2008), farm production in irrigation and rainfall-based areas has big difference in their productivity. He found that the farm production produced based on irrigation was high due to post harvest storage facilities and doubling or tripling effects of irrigation while the rain-fed areas produced subsistence crops and encountered a chronic food deficit. A study conducted by Hagos et al. (2009) also indicated that irrigation in Ethiopia increased yields per hectare, income, consumption and food security.

2.5. Definition and core Concepts of Food Security

2.5.1. Definition of food security

Food security is defined by different agencies and organizations differently without the alteration of the basic concept. UN (1990) defines household food security as “The ability of household members to assure themselves sustained access to sufficient quantity and quality of food to live

active healthy life. “Food security can be described as status in which production, markets and social systems work in such a way that food consumption needs of a country and its people are always met. Moreover, FAO (1992) defines food security not only in terms of access to, and availability of food, but also in terms of resource distribution to produce food and purchasing power to buy food, where it is produced.

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

Food security is also defined in different ways by different organizations around the world. For example, in 1996, the definition of food security was agreed and accepted at the World Food Summit in Rome and it was defined food security as a physical and economic access by all people at all times to sufficient, safe and nutritious food to meet their dietary needs and food preference for an active and healthy life (Todaro and Smith, 2011). This definition contains different features, such as food availability, accessibility, utilization and stability. Food availability refers to the existence of food from own production or on the markets. It is a combination of domestic foods production, marketable imports and food aid. It also refers to food supplies available at both the household level and at a national level. However, it is applied most commonly in reference to food supplies at the regional or national level. But food access concerns about having adequate resources to obtain appropriate foods for a nutritious diet through a combination of home production, stocks, purchase, and gifts, borrowing or food aid. Food access is guaranteed when households and all individuals within them have adequate resources, such as own production, stocks, purchases, gifts, borrowing or aid. Households‟ wealth is an important determinant for food access when regular livelihood strategies are compromised by poor agro-climatic conditions, high prices, loss of employment, or illness.

Food utilization has a socio-economic and a biological aspect. It refers to nutritional and safety aspects of food security to meet adequate diet, clean water, sanitation and health care to search a state of nutritional wellbeing. It also refers to the household’s knowledge of nutrition and

childcare techniques. Food Stability complements the previous factors by stressing that food must be available, accessible, affordable and properly utilized on a continuous, long-term basis. It refers to the level of resilience to shocks and other crises. The world had about 800 million food insecure and malnutrition people in 2011 (FAO, 2011). Similarly, Ethiopia had about 3 million (200 thousand in Tigray) food insecure and malnourished people (MoFED, 2012).

2.5.2. Core Concepts in Household food security

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

2.5.2.1. Sufficiency: What is "Enough?"

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

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

2.5.2.2. Access and entitlement

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

A household's access to food also depends on the resources available to individual household members and the steps they must take to obtain those resources, particularly exchange of other goods and services (Bilinsky and Swindale, 2005). In the same manure Debebe(1995); Sen (1981) sated the basic resources like cash, labor, land, markets and public services determine the possibility of increasing entitlement to food. These are the key factors for either promoting food security or increasing vulnerability to food for either promoting food security or increasing vulnerability to food insecurity.

2.5.2.3. Security

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

2.5.2.4. Time

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

Chronic food insecurity means that a household runs a continually high risk of inability to meet the food needs of household members. In contrast, transitory food insecurity occurs when a household faces temporary decline in the security of its entitlement and the risk of failure to meet food needs is of short duration. Transitory food insecurity focuses on intra and inter-annual variations in household food access. This category can be further divided in to cyclical and temporary food insecurity. Temporary food insecurity occurs for a limited time because of unforeseen and unpredictable circumstances. Cyclical or seasonal food insecurity occurs when there is a regular pattern in the periodicity of inadequate access to food. This may be due to logistical difficulties or prohibitive costs in storing food or borrowing (Maxwell and Frankenberger, 1992).

2.6. Empirical studies on Small-scale Irrigation and Food Security

This study was reviewing the economic contribution of small-scale irrigation on rural household food security. Irrigation investment in India enabled farmers to increase diversification of crops, and use of more chemical inputs like pesticides, fertilizers or improved seed varieties (Bhattarai et al., 2007) and switched from low-value subsistence production to high-value market-oriented production in China (Muez.2014).

Appropriate technologies have been introduced depending on the socio-economic conditions of chronically food-insecure households and different menus of technological packages have been prepared and disseminated to these households through the extension services. The packages include provision of improved inputs to increase livestock and crop production and productivity, moisture conservation and utilization, credit, training, support for additional income-generating activities, and provision of market information. The core objective of the food security program is to increase food availability and access at household level through increased crop production and productivity, increased livestock production and productivity and increased access to other non-farm income through agricultural and non- agricultural activities (MoFED, 2010).

A study made in socio-economic assessment of two small-scale irrigation schemes in AdamiTulluJidoKombolcha Woreda, Central Rift Valley of Ethiopia, the result showed that irrigation schemes increased households' income compared to situation before implementation of

the schemes and thus contributed to improvement of household food security status (Mengistu, 2007).

Farmers in rural areas suffered from persistent poverty and food insecurity due to climatic changes and dependent on variable rainfall. This leads to low agricultural productivity. As a result, the low productivity areas characterized by persistent rural poverty and increasing population pressure have often resulted in a vicious circle of poverty and environmental degradation (Von Braun, 2008). As many of the low productivity areas did not use water resources, irrigation development is recognized as a backbone of agricultural productivity, enhancing food security, earning higher incomes and increasing crop diversification (Smith, 2004). In many developing countries, small scale irrigation schemes were considered to increase production, reduce the risk of unpredictable rainfall and provide food security and employment to poor farmers (Muez.2014).

Employing different research methodologies, the findings of the above reviewed empirical studies clearly revealed that there is no consensus as there are conflicting evidences from different projects and regions about the sustainable role of irrigation towards food security. Moreover, in the study area, to the best of my knowledge no empirical study was conducted so far on the raised issue. Accordingly this study is intended to fill the above mentioned gaps.

2.7. 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 which includes 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.

2.8. Conceptual Framework of Household Food Security and Determinant Factors

As clearly discussed in literature review section and as revealed in figure 1 below household food security was 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 three categories. Demographic characteristics which includes age, sex, educational level of the household head, family labor and dependency ratio ; institutional factors category includes access to credit, health status , contact with development agent and food aid; Socio-economic factors involves, farm size, livestock size and non-farm income activity.

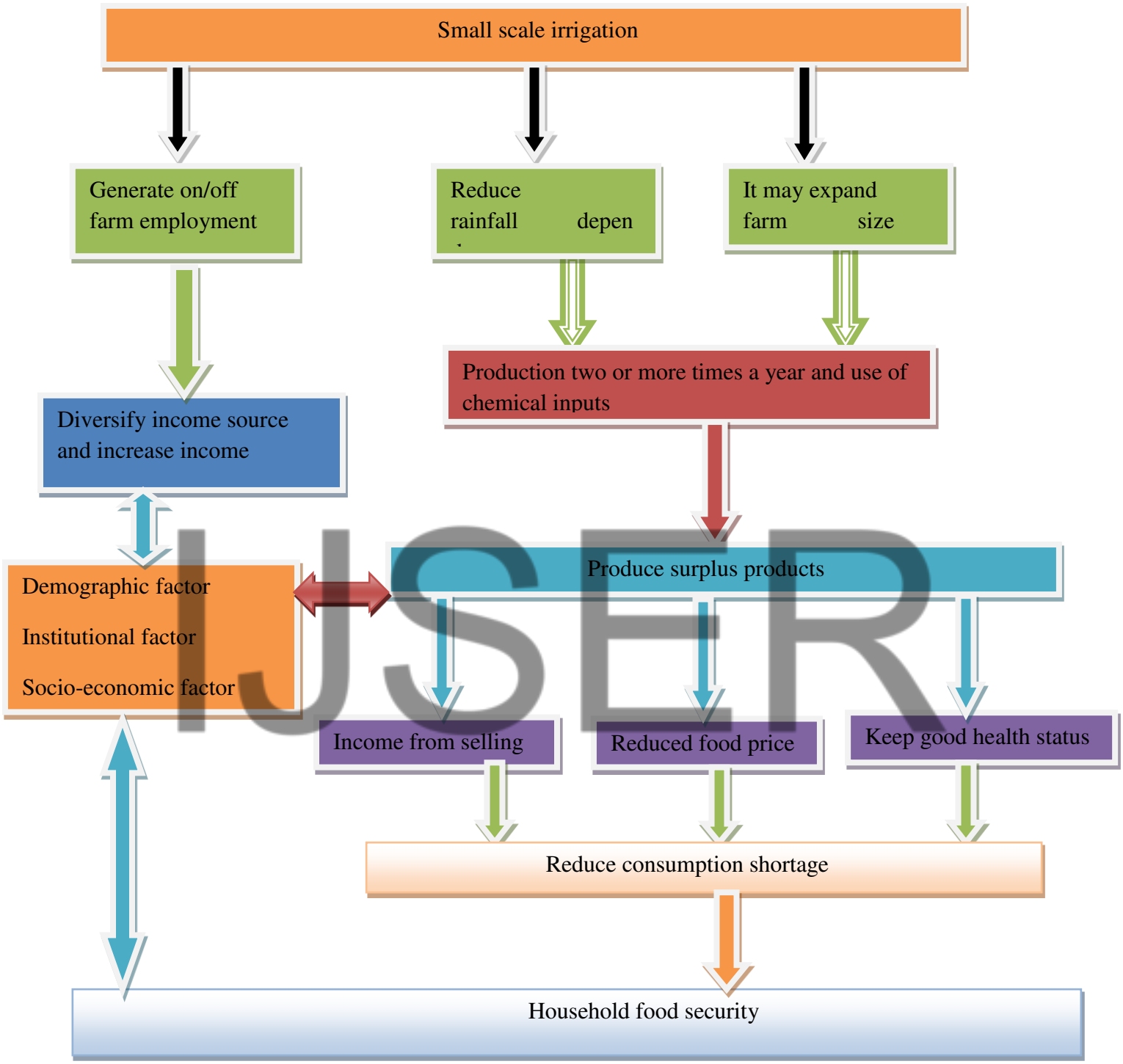

Figure 1: Conceptual framework Irrigating food security linkage

Source: Nugusse (2012)

CHAPTER THREE
RESEARCH METHODOLOGY

Introduction

This chapter outlines how the study was conducted to ensure that the most valid findings were reached. The most appropriate procedures are performed in order to provide answers to the research objectives. These include types of research design employed, data collection instruments, the sampling method, data management and data analysis.

3.1. Description of the Study Area

3.1.1. Location

Abergelle Woreda is located between 12^0 50'N-13^0 20' N latitudes and 38^0 39' E- $39^0$11'E longitudes in Wag Himra zone of the Amhara regional state. Abergelle Woreda bordered Beyada woreda with north Gonder Zone, Ziquala woreda in the west, Sekota in the south, Maychew (South Tigray) in the East and north Gonder zone Beyada woreda in the south.

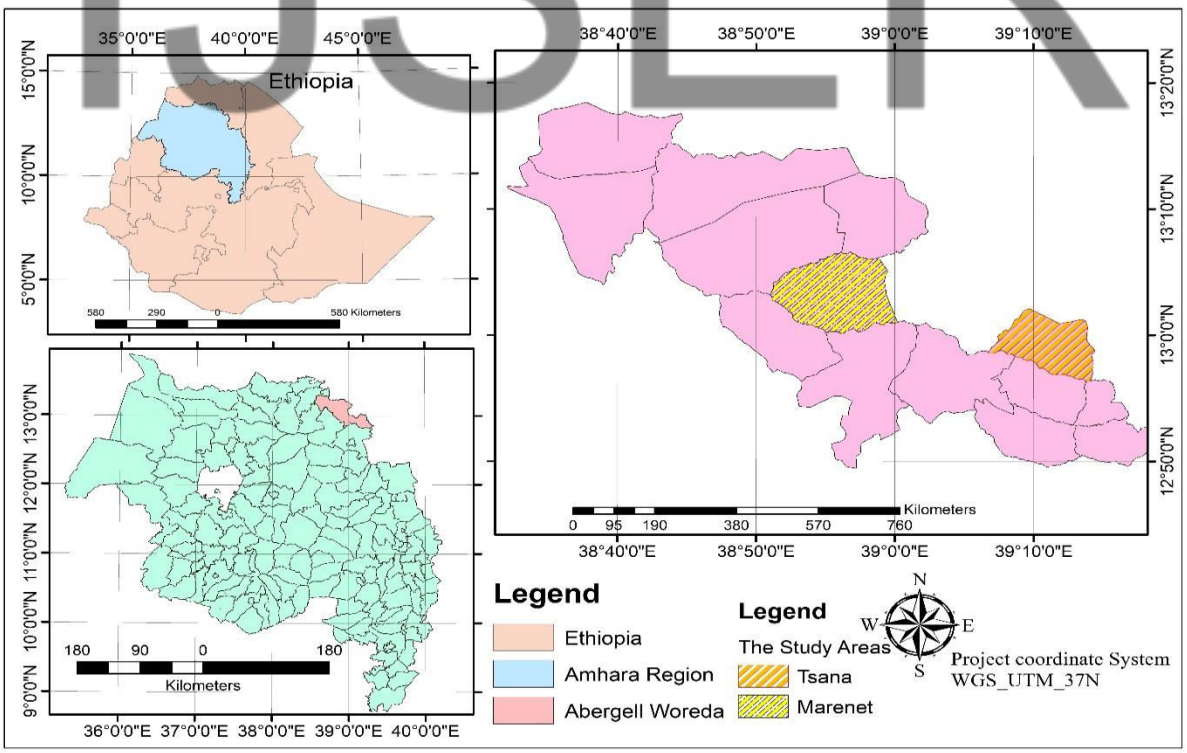

Figure 2: Map of study area: Abergelle

Source: Ethio_GIS (2015)

3.1.2. Geographical Setting

According to Abergelle Woreda agricultural and rural development office (2018), Abergelle Woreda is one of Wag Himra zone of Amhara regional state bordered with north Gonder Zone Beyada woreda and Ziquala woreda in the west, Sekota in the south, Maychew (South Tigray) in the East and north Gonder zone Beyada woreda in the south. Economically, the people of Abergelle Woreda lead a life proportioned to the other people of northern Ethiopia. They largely depend on agricultural activity: both farming and animal husbandry. It is, however, cultivation of crops that is valued most in many parts of the Woreda though animal husbandry as a dominant economic subsistence is confined to people living along the courses of the Tekeze River. The altitude of the area ranges from 989 – 2823 masl and the mean annual rainfall is 250 to 500 mm. Most part of the cultivated land is situated on the middle and lower altitude. The most common types of crops in the area include: teff, wheat, barley, Sesame, sorghum, maize and sun flower. Farmers plant like millet, sorghum and maize when the summer rainfall is favorable. If the summer rains are absent they plant short season crops like Check pea, Sorghum, Sesame and Teff. The average crop production is 2 quintals per hectare. In general; the feed resource is not compatible with the number of livestock in the woreda. There is very high deficit of forage both in wet and dry seasons.

The woreda has a total land size of 160,659.64 ha. Out of the total area of the woreda 17941 ha of land is used for crop production, of which 419.64 ha is potential land for irrigation, 12345 ha covered by forest, 87601 ha for grazing land, and 4113 ha for homestead and 38240 ha is miscellaneous land. The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction. The agricultural production is mostly based on rain-fed agriculture with some traditional irrigation. Average farm size is 0.50 ha. Sowing is mostly practiced with broadcasting method and harvesting is done with sickle mowing and threshing by oxen trampling.

The woreda has a total population of 66,360 in 16 kebeles. The woreda has a total farm land of 17,941 ha of which 419.64 ha can be used for irrigation farming. In 2019, around 419.64ha of land were under irrigation from different water sources. There are six small scale irrigation dams

in the woreda namely Newraqe (01) kebele Zamera river, and Tirarya river (03) kebelle diversion with a total potential of irrigating 299.78 ha where 270 farmers HH are beneficiaries. On average the irrigable land size of a household is 0.20 to 0.25 ha. Farmers in the woreda also practice irrigation from water ponds, diversion, motor pups, etc. according to the woreda office of agriculture there are 4116 farmers practicing irrigation. Adisking (05) is one of the kebele where the Adisking 1 irrigation scheme is found. Prior to the project, the community had been under serious food stress and survived mainly by external food aid. Despite the fatal food insecurity problems in the area, the area has endowed with huge potential of irrigable fertile land in the Dura kebele.

3.1.3. Climate

Environmental and weather condition of the district is characterized by low, variable and erosive rainfall and frequent drought. According to the meteorological data (1996 to 2020) found from NMA of Ethiopia indicates that the average annual rainfall is 548.3, that ranges between 250.2 mm and 550.5 mm.

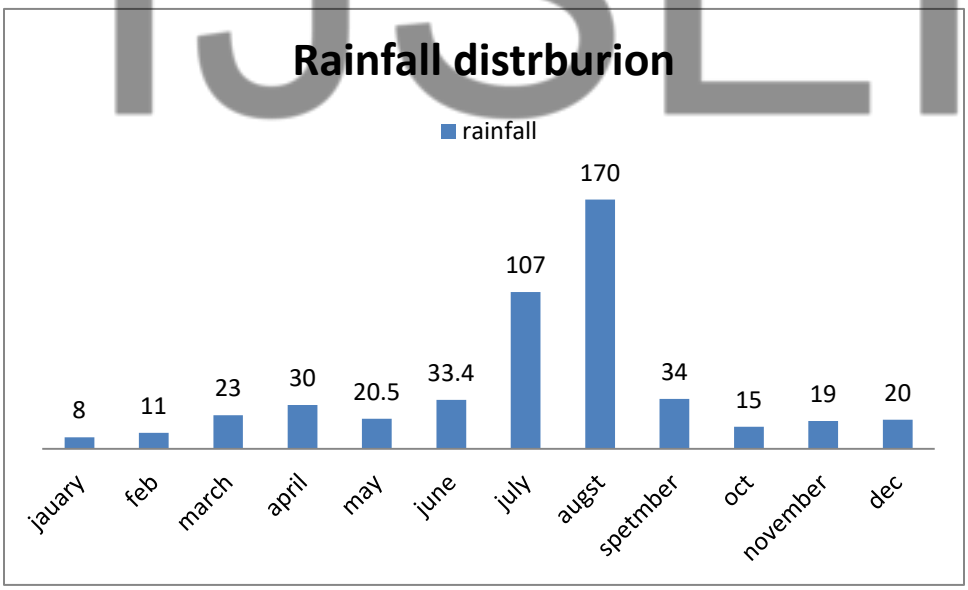

Figure 3: Average Rainfall Distribution

Source: NMA

The temperature of the study area, the long-term (1996-2020) annual average maximum temperature is computed below 43°C, the annual average minimum temperature is 12.7°C and the average temperature of the study area is found 23.5°C.

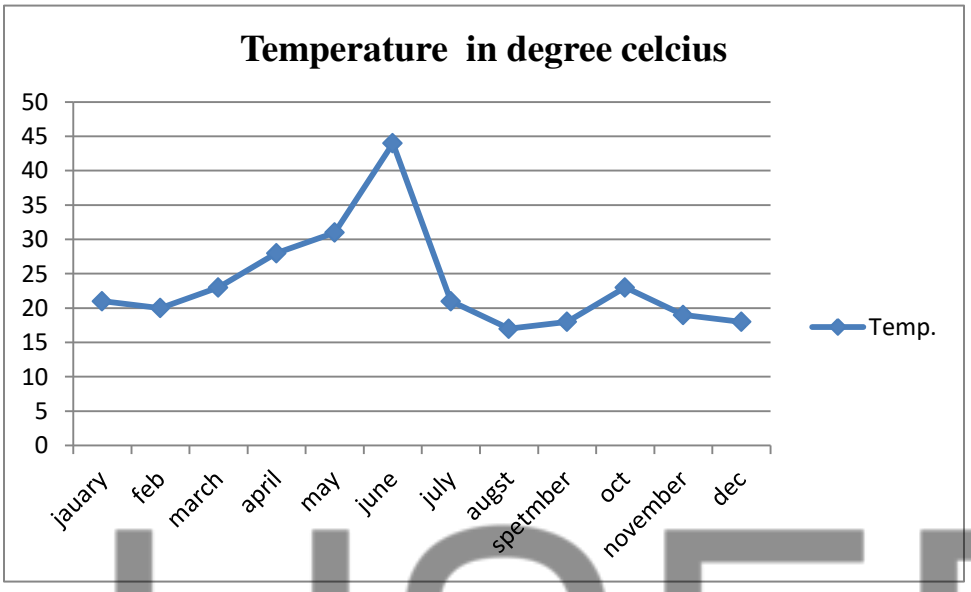

Figure 4: Average Temperature

Source: NMA

3.1.4. Population

Currently, the district has a total population of 6360 out of which 33313 (50.2 percent) are male and 33047 (49.8 percent) are female. In terms of age category 44 percent of the population is under the age of 15 and 4.43 percent of the population are above the age of 64, while 51.88 percent of the population is categorized to the age group of 15-64, (CSA, 2007 and Data extrapolated).

3.1.5. Agriculture

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

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

In general, the fodder resource is not compatible with the number of livestock in the Woreda. There is very high deficit of forage both in wet and dry seasons. The Woreda has a total land size of 160659.64. Out of the total area of the Woreda 17941 ha of land is used for crop production, of which 419.64 ha is potential land for irrigation, 12345 ha covered by forest 87601 ha for grazing land, and 4113 ha for homestead and 38240 ha is miscellaneous land. The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction. The agricultural production is mostly based on rain-fed agriculture with some traditional irrigation. Average farm size is 0.50 ha. Sowing is mostly practiced with broadcasting method and harvesting is done with sickle mowing and threshing by oxen trampling. The present land use is characterized by low input, small- holder farming system performed by local peasants at sub-intensive level with low market orientation and with strong orientation towards production of grain for which cattle provide traction.

3.2. Description of the irrigation scheme

The study area is found in the Wag Himra zone of Amhara Region. This district is selected because of the researcher's attachment to the project areas and relatively better irrigation practices with the use of small-scale irrigation scheme. Newraqe (01) kebele: Zamera river and Tirarya river (03) kebele diversion with a total potential of irrigating 299.78 ha where 270 farmers HH can be beneficiaries. The irrigable land in the command area was distributed to farmers by the government. Except few farmers who lease in additional irrigable land almost all farmers in the area own quarter of a hectare (one Timid).This study is conducted on two small scale irrigation schemes that are found in Abergelle Woreda district of Amhara regional state; namely Newraqe (01) kebele Zamera River and Tirarya river (05) kebele diversion.

3.3. Research Design

The research design employed for this paper was descriptive survey research (cross sectional study). The cross-sectional research design was employed because it enables researchers to identify the proportions of people in particular groups or states and it uses large samples that enable inferential statistics to be used, e.g. to compare subgroups within the sample. Moreover, it enables prediction and projection based on identified and monitored variables and assumptions. Therefore, comparative cross-sectional method was used also to investigate the determinant factors of food security, and challenges of small-scale irrigation in Abergelle Woreda. Furthermore, for the purpose of achieving objectives of the research quantitative and qualitative research approaches were employed.

3.4. Sampling Design

3.4.1. Sample size determination

Based on the nature and size of the universe (population); nature of the study and sampling techniques; sample units; time and financial resources, the study first specifies the total population of the study in terms of the total number of HH in the selected kebeles. Since the total population of the study is finite, a conventional sampling strategy was used at 95 percent confidence level and 3 percent confidence interval (L. Cohen et al, 2007).

Accordingly, since the total number of households of the two kebeles is 1726; given the confidence level and confidence interval the random tables of sample size suggests 332 households are reasonable to use as representative of the total households in the two kebeles (Cohen, 2007).

Furthermore, since the sample HH are comprised of different strata; Male headed and Female headed HH, the study employed proportional allocation method in which the sizes of the samples from the different strata are kept proportional to the sizes of the strata. Hence, using stratified proportional sampling the sample size of each stratum has been calculated as follow:

No. of sample HH of stratum X=n/N*Z

Where n=total sample frame HH= 332

N=total HH=1726

Z= no. HH in stratum X

Therefore;

- n of Non-Beneficiaries HH =332/1726*1245

  =239

- n of Beneficiaries HH = 332/1726*481

  = 93

3.4.2. Sampling Technique and Procedure

The researcher used both probability and none probability sampling technique. Abergelle Woreda is selected purposely for this study because the area is identified as one of the droughts induced food insecure Woredas and the area practice small scale irrigation for long time than other Woredas in Wag Himra Zone of Amhara National Regional State (ANRS). It encompasses sixteen "kebeles" inhabited by people with diverse socio-economic and demographic characteristics. To select sample from the population a multi-stage stratified sampling design was used. Using the report from Abergelle Woreda Agriculture office, the first stage of sampling was to select two kebeles which have Small Scale Irrigation. Accordingly, this study selected kebele 01 and 05 of Abergelle Woreda based on the wide and long practice of SSI and accessibility of the Kebeles that would make the study practical.

Table 1: Distribution of samples across the two kebeles

Kebeles	Total HH				Beneficiaries of SSI				Non-beneficiary			
	MHHH	FHHH	T	Sample	MHHH	FHHH	T	Sample	MHHH	FHHH	T	Sample
01	832	347	1179	**239**	137	81	218	**42**	695	266	961	**185**
05	413	134	547	**93**	200	63	263	**44**	213	71	284	**61**
Total	1245	481	1726	**332**	337	144	481	**86**	908	337	1245	**246**

Source: Abergelle woreda Agriculture and Extension Office, 2019

At the second stage of sampling; probability sampling was used. Based on the most recent household listings that has been obtained from 'kebeles' authority and Agricultural Extension Office, a stratified random sampling technique was employed to determine sample size of the study which has been used to select sample household heads within the selected kebeles. The stratification was mainly based on Small Scale Irrigation beneficiaries HH and non-SSI beneficiaries HH. Furthermore, the households were stratified into Male headed HH (MHHH) and Female headed HH (FHHH). The rationale for stratifying the HH into MHHH and FHHH is to get the gender dimension of household food security in relation to the use of SSI in the study area. Hence, stratified random sampling technique was employed to select sample HH from each stratum. Stratified random sampling has some advantages over random sampling, for instance in the case of stratified random sampling, researchers can have the facility to generate separate results for each stratum, which can not only provide important information about that stratum but can also provide comparative results between strata (Kothari, 2007). Moreover, focus group discussions members were selected at each study areas using convenience sampling (one of non-probability sampling technique) and each focus group member in the two kebeles comprised six to eight individuals. In order to enhance the information two experts from two different departments, such as irrigation and Productive Safety Net Program expert, one development

agents (DA) from each kebeles were added to the focus group discussion group. Furthermore, for key informant interview one committee member of irrigation water user's association, two experts from two different departments, such as irrigation and Productive Safety Net Program expert, one development agents (DA) from each kebeles were included using the same technique.

3.5. Reliability Test

The criteria of Cronbach's alpha for establishing the internal consistency reliability are: Excellent ($\alpha>0.9$), Good ($0.7<\alpha<0.9$), Acceptable ($0.6<\alpha<0.7$), Poor ($0.5<\alpha<0.6$), Unacceptable ($\alpha<0.5$).

Table 2- Cronbach's Alpha VARIABLES NO. OF ITEMS

VARIABLES	NO. OF ITEMS	CRONBACH'S ALPHA VALUE
Overall	52	0.829
Determinant factor	32	0.902
Situation of food security	11	0.769
Household food consumption	4	0.506
Household Dietary diversity	5	0.874

Source: own calculation, 2020

Based on the above table, the overall Cronbach's alpha value is 0.829. This shows that the collected data have a good reliability in internal consistency. Determinant factor has the highest Cronbach's alpha value (0.902). This shows the highest reliability in internal consistency of 32 questions. Status of food security has the second highest Cronbach's alpha value (0.769) which means that the data is highly reliable. HH Consumption pattern has the lowest Cronbach's alpha

value (0.743) which shows the data has highest reliability. The HH dietary diversity in Cronbach's alpha value is 0.874 which also shows that data is highly reliability in internal consistency.

3.6. Data Type, Data Source and Data Collection Instruments

3.6.1. Data Types and Data Sources

This study 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. Quantitative data was collected 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 two 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.

3.6.2. Data Collection of instruments

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

3.6.2.1. 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, so that the respondents can easily understand the questions. Two 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.

3.6.2.2. Focus Group Discussions

The focus group discussions (FGD) members composed of both men and women who were not involved in the individual interviews. One focus group discussion at each study areas was 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 farmer have been faced irrigation activity.

3.6.2.3. 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 kebeles, one committee member of irrigation water user's association from each kebeles was included as a key informant interview.

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

3.7.1. Household Food insecurity Access Scale

Food and Nutrition Technical Assistance (FANTA) Project and its partners have identified a set of questions that have been used in several countries and appear to distinguish the food secure from the insecure households across different cultural contexts. Household food insecurity access scale (HFIAS) generic questions are 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.

3.7.2. 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 were regarded as medium dietary diversity and ≥6 food groups were regarded as high dietary diversity.

3.7.3. Food Consumption Score

To estimate the FCS, foods were regrouped into eight standard food groups. 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.

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.

Table 3: The weight of food groups

Food groups	Main staples	Pulses	Vegetables	Fruit	Meat and fish	Milk	Sugar	Oil

Weight	2	3	1	1	4	4	0.5	0.5

Source: World Food Program, 2008

3.7.4. 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.

3.8. Method of Data Analysis

The data collected using the above tools was coded and enter in statistical software known as Statistical Package for Social Sciences (SPSS -23). Concomitantly, both descriptive and inferential data analyses were employed. Besides, household Food Insecurity Access Scale (HFIAS) which examines the food security status of households was employed. Determinants of household food security were identified using binary logistic regression model. Moreover, Household Dietary Diversity has been used to analyze the diversity of food users between irrigation users and non- irrigation user in the study area.

3.8.1. 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 regarding 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 determinants of 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:

$$Pi = \frac{ez^i}{1+ez^i} = \text{----------} \mathbf{1}$$

Where pi =was the probability that an individual is being food secure for the ith household and ranges from 0 to 1.e = Represents the base of natural logarithms and Zi= is the function of a vector of n- explanatory variables(x) and expressed as

$$Zi = \beta 0 + \sum \beta iXi + ui \text{ ----------} \mathbf{2}$$

Where β0= is the intercept Bi = is regression coefficients to be estimated,

Xi= is Variables and ui = is a disturbance term

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

$$1\text{-Pi} = \frac{1}{1+ez^{i}} = \text{----------} \mathbf{3}$$

Then odds ratio can be written as:

$$\frac{Pi}{1-Pi} = 1 - \frac{1+ez^{i}}{1+e-z^{i}} = ez^{i} \text{----------} \mathbf{4}$$

Equation (4) was indicates simply the odds ratio. It was the ratio of the probability that the household was food secure (Pi) 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:

$$Li = Ln\left(\frac{Pi}{1-Pi}\right) = Ln(e\beta o + \sum_{j=1}^{n} \beta j Xij = Zi = \beta o + \sum_{j=1}^{n} \beta j Xij + Ui \text{----------} \mathbf{5}$$

Where Li was log of the odds ratio, which was not only linear in Xji but also linear in the parameters.

Description of Explanatory Variables and Hypothesis

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.

Sex of Respondent Households (HHSEX): This is a dummy variable with values1for male and 0 otherwise. Male household heads are expected to have higher income compared to female

household heads because of better labor inputs used and with regard to farming experience. Male headed farmers are also better than the female headed farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the small-scale irrigation as early as possible and their income is higher than their counterpart. According to Bradshaw (2006) gender is an important determinant in technology adoption. Men often control household finances and decisions regarding purchases of agriculture technology and inputs (Knowler and Bradshaw 2006). Hence this study was hypothesized male headed households were more likely to participate in the small-scale irrigation scheme in the study area.

Education Level of a Household Head (HHEDUC): It is an ordinal 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 fulfill 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 family size (HFSIZE): It is measured in the number of peoples living in the household converted in to adult equivalent. For farming activity, the labor force in the family is essential in order to be food secured. A household who has a greater 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 ratios (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 has 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 influencing the food security situation. It was measured in days per year that the household head was sick (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' contacts 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 conditions of food security. As a result, positive relationship would be expected between contacts with development agent and food security status.

Access to Credit (ACREDIT): It is 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 a greater 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.

Access to Irrigation (ACCIRR): was a dummy variable 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 produce 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 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.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents the result and discussion of the study. It is divided into three subsections; the first sub section summarizes results by using descriptive statistics such as means, percentages and frequencies to describe the characteristics of sample households by using explanatory variables. The second sub-section focuses on measuring household 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. Finally, the third sub section presents the results from econometric analysis that identifies the major factors that affect household food security.

4.2. Description of the Sampled Household Characteristics

This section describes the household characteristics 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 secure and food insecure) of sample respondents were compared with respect to independent variables.

4.2.1. Sex of Respondent Households

According to the survey result, out of 332 samples household head respondents, 89.2% of them were males and 10.8% were females. From the total food secure households 91.3% were male headed while the rest 8.7% were female headed. On the other hand, 83.5% food insecure households were male headed and 16.5% were female headed. As indicated below in table -4, the Pearson chi-square statistics is 4.125 with 1 degrees of freedom and a 2-sided p-value of $p=0.04<0.05$ at 5% probability level. This significant value of chi-square test states the existence

of food security status disparity between sample female and male headed households. Hence it can be inferred that compared with female headed households, male headed households are more food secured.

Table 4: Distribution of household heads by sex

Variable	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Sex of Respondents							
Female	21	8.71	15	16.48	36	89.16	4.125**
Male	220	91.3	76	83.5	296	10.8	

** Pearson Chi-square is significant at 5% level of significance.

Source: own Survey Result, 2019

4.2.2. Educational Level of Respondents

The result of the survey in table 5 shows that 78.6 % of the respondents had formal education whereas 21.4% had no formal education. Regarding food secure households, 90.9 % had formal education where the rest 9.1 % households had no formal education. On the other hand, out of the food insecure households 46.2% had formal education while 57.4% had no formal education. This indicates that households with better educational background are more food secure than households with no education. Moreover, as indicated below (table -5), the Pearson chi-square statistics is 78.569 with 1 degrees of freedom and a 2-sided p-value of $p=0.01<0.05$ at 5% probability level. This significant value of chi-square test states the presence of food security status difference between sample household heads that are literate and those household heads that are illiterate. Hence it can be inferred that compared with household headed by illiterate household heads, households headed by literate households' heads are more food secured.

Table 5: Education Level of Sample Respondents

Variable	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Education Level of Respondents							
Unable to Read and Write (illiterate)	22	9.1	49	57.4	71	21.4	78.569**
Formal education	219	90.9	41	42.6	261	78.6	

** Pearson Chi-square is significant at the 5% level of significance.

Source: own Survey Result, 2019

4.3. Annual Mean Income of Sample Households

Figure 3 below shows that irrigation user households had obtained an annual mean income of 15,930.49 ETB from cash crop production while non-user respondents had obtained mean annual income of 9,501.74 ETB. This shows that irrigation user households earn higher income from cropping than non-irrigating households.

Furthermore, the mean non-farm incomes for irrigating and non-irrigating households were 11,369.43 ETB and 6,548.93 ETB respectively. Irrigating households had larger non-farm income than non-irrigating households.

With regard to total mean annual income from farm (irrigation) and non- farm; irrigating households earn 27, 299.91 ETB while that non-irrigating households earned about 16,050.66 ETB. This is the sum of average income earned from farm production such as been keeping, poultry, fruit and vegetable and non-farm economic activities such as petty trade, charcoal and wood selling and self-employee. Moreover, data from the key informants and the focus group

discussion participants' result shown us, the income earned from non-farm activities was higher among irrigation users than non-users.

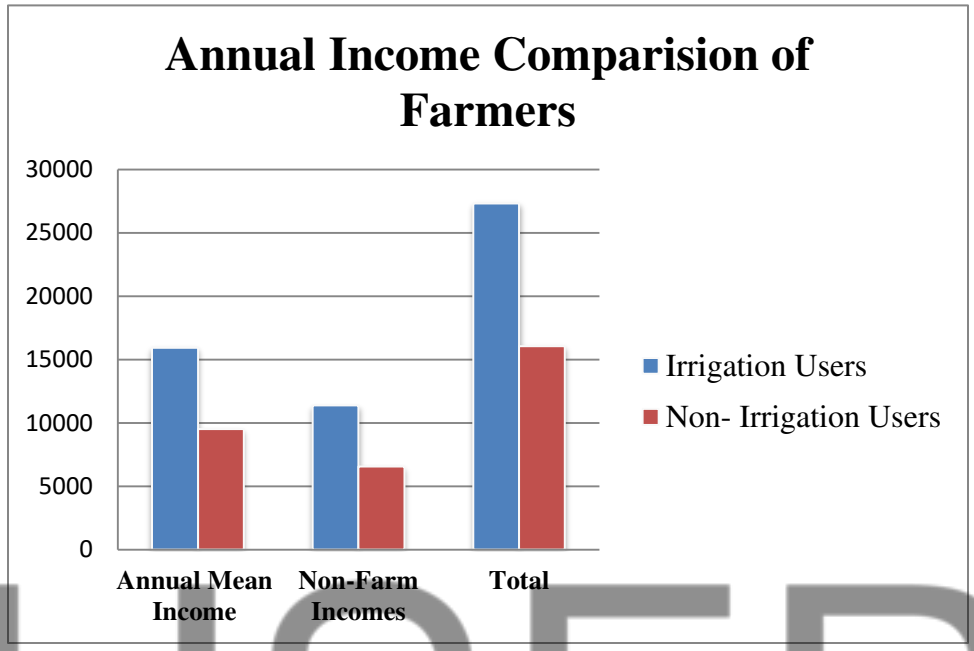

Figure 3: Income Level of Sample Households

Source: own Survey Result, 2019

4.4. Sources of Irrigation Water

The survey result in Table 6 below shows that out of the total irrigation user respondents, 12.8% had got irrigation water from rivers, 61.6% of respondents had got irrigation water from springs and 25.6% of respondents had used their irrigation water from ponds.

The result of the survey also shows that most irrigation user respondents depend on spring to irrigate their farmland. Farmers, who had farmlands far from springs, also used ponds and rivers. The ponds were constructed by individual farmers at and near their farmland and used as an alternative source of irrigation water.

Table 6: Sources of Irrigation Water for sample households

Source of Irrigation Water	Frequency (N=86)	Percent
Spring	53	61.6
Pond	22	25.6
River Diversion	11	12.8
Total	86	100

Source: Own Survey Result, 2019

4.5. Organizational Support for Irrigation Management

Table 7 below revealed that from the total number of respondents who have been practicing small scale irrigation 34.3% were supported by the LIVES project. From the services or supports of the project 15.8% of the respondents were provided by improved irrigation technologies, 75.4% were exposed for improved irrigation practices and 8.8% were benefited from demonstration of applicable technologies in irrigation.

Concerning benefits, 33.3% of respondent households reported that LIVES project improved their household food security while 66.7% of the respondent households believed that the support has increased their crop productivity. This shows that, respondent households were more benefited from this livestock and irrigation value chains for Ethiopian smallholders (LIVES) project. Moreover, data from the key informants and the focus group discussion participants' results revealed that, the farming community benefited from this livestock and irrigation value chains for Ethiopian smallholders (LIVES) project.

Table 7: Organization Support on Irrigation Water Management

Activities	Frequency (N=86)	Percent
Are you supported by Livestock and Irrigation value chains for Ethiopian smallholders		
Yes	86	25..9
No	246	74.1
What benefits did you get from this project?		
Exposure for improved technology	14	15.8
Exposure for improved practices (practical lessons)	65	75.4
Demonstration to applicable technologies	7	8.8
Is there any change on household food security and production after the support?		
Yes	86	100
No	0	0
What is the change?		
Improved household food security	29	33.3
Increase the Crop productivity	57	66.7

Source: Own Survey Result, 2019

4.6. Access to Irrigation

As presented in Table 8 below, 31.5% of the food secures and 11 % of food insecure households had access to Irrigation. On the contrary, 68.5% food secure and 89% of food insecure households had no access to irrigation. The result of the survey indicated that, households who have access to irrigation were food secure than who have no access. Moreover, as indicated below the table, the Pearson chi-square statistics is 36.691 with 1 degrees of freedom and a 2-sided p-value of p=0.003<0.05 at 5% probability level. This significant value of chi-square test states the existence of food security status gap between samples that have access to irrigation and those households who do not have access to irrigation. Hence it can be inferred that compared with households who have no access to irrigation, household those who have access to irrigation were more food secured. Furthermore, a finding from key informant and focus group discussion participation is in line with the above discussion.

Table 8: Irrigation Use of Sample Respondents

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Access to Irrigation							
No	165	68.5	81	89	246	74.1	
Yes	76	31.5	10	11	86	25.9	38.691**

**Pearson Chi-square is significant at 5% level of significance

Source: Own Survey Result, 2019

4.7. Household member's Health Status

Table 9 below indicated that out of the sample households 80.1% reported that their household members not to have health related problems currently while 19.9% of them reported that some of their household members were suffering from certain sickness. Looking into the relationship between household members' health status and food security of the households, 80.5% food secure households reported to have healthy family while the remaining 19.5% reported to have sick family members. On the other hand, out of the total food insecure households, 79.1%

reported to have certain health problem currently while 20.9% were reported that they didn't have any sick family in the study period. Moreover, as indicated in table 9 below, the Pearson chi-square statistics is 19 .5with 1 degrees of freedom and a 2-sided p-value of p= .079 > 0.05. There was no significant difference in health status between food secure and food insecure households. Hence it can be inferred that health has no significant effect on household food security in the study area.

Table 9: Sample Household member's Health Status

Variable	Food secure N=241		Food insecure N=91		Total N=332		X^2
	Frequency	%	frequency	%	Frequency	%	
Is there anyone who is currently sick in your Household?							
No	194	80.5	72	79.1	266	80.1	19.5**
Yes	47	19.5	19	20.9	66	19.9	

**Pearson Chi-square is significant at 5% level of significance.

Source: Own Survey Result, 2019

4.8. Contact with Extension Agent

Table 10 below also shows that the number of contacts per months that the respondents made with extension agent (Agricultural Development agents). Accordingly, 22.8% the food secure households contacted agricultural development agents more than two times, while 19.8% of the food insecure households made similar contact. On the other hand, 55.2% food secure households contacted agricultural development agents two times per month while 52.7% of food insecure households did make the same contact. Moreover, 22.0% food secure and 27.5% food insecure households made contact only once a month. Furthermore, as indicated in table 10 below, a one-way ANOVA was performed to compare the impact of frequency of DA's contact on food security of household heads. Frequency of DA's contact with household heads was divided into three groups. The outcome variable was found to be normally distributed and equal variance are assumed based upon the result of levene's test (F (332) =0.746, P=0.475). There was no significant difference in frequency of contact with development agent for three groups (F

(2,331) =4.6, P=0.036). Thus there was no significant mean difference regarding number of contacts with agricultural development agents between food secure and food insecure households at 1% significant level. Hence it can be inferred that contact with extension agent has no significant effect on household food security in the study area.

Furthermore, the data collected from key informants and the focus group discussion participants' results shown us, the farming community in the two kebeles was very much aware the importance of frequent contact with extension agent.

Table 10: Sample households' frequency of Contact with Extension Agent

Variable	**Food secure N=241**		**Food insecure N=91**		**Total N=332**		ANOVA (p-values)
	frequency	**%**	**frequency**	**%**	**Frequency**	**%**	
Frequency of Contacts with DA							
One times	53	22	25	27.5	78	23.5	0.036**
Two times	133	55.2	48	52.7	181	54.5	
More than two	55	22.8	18	19.8	73	22	

** 5% level of significance

Source: Own Survey Result, 2019

4.9. Respondent Households' Participation in Non-farm Activities

Rural households often engage in different activities in addition to the agricultural sector to improve their food security status and income. Similarly, 53.0% of the total sampled households reported to participate in non-farm income generating activities compared to 47.0% households who did not participate. Moreover, out of the food secure households 50.6% reported to participate in non-farm activities while the rest 49.4% of them didn't. Contrary, 37.6% of the food insecure households testify that they participated in different non-farm activities while 62.4% of them didn't participated as indicated below in the table 11. Moreover, majority of the households have been participating in top four activities: petty trade (43.6%), self-employment (18.1%), sell labor (14.9 %) and (7.4 %) shops. On the other hand, 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 of the study further shows that many food secure households have engaged in various non-farm activities compared to the food insecure households. This implies that engagement in non-farm activities could be more important to increase the annual income and food availability of farm households. Moreover, as indicated below in table 11, the Pearson chi-square statistics is 4.663 with 1 degrees of freedom and a 2-sided p-value of p= .073> 0.05. There is no significant difference among sample households that participant in non-farm activity and those are not. Hence it can be inferred that non-farm activity has no significant effect on household food security in the study area. The idea mentioned in the above statement is also highly supported by key informants' interview and focus group discussion made in the two kebeles.

Table 11: Participation of sample households in Different non-farm Activities

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Participation in Non-farm Activities							
No	119	49.4	57	62.6	176	53.0	
Yes	122	50.6	34	37.4	156	47.0	4.663**
Type of Non-Farm Activities							
Hire out labor	0	0	3	3.2	3	0.9	
Cash for work	27	11.2	7	7.6	34	10.5	
Food aid	17	7.0	8	8.7	25	7.5	
Sale of firewood	15	6.2	5	5.4	20	6.0	
Self-employment	27	11.2	4	4.3	31	9.3	
Petty trade	36	14.9	6	6.5	42	12.6	
Village shop	0	0	1	1.0	1	0.3	

**Pearson Chi-square is significant at the 5% level of significance

Source: Survey Result, 2019

4.10. Access to Credit services

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. As indicated in Table 12, out of the total sampled households only 19.9% of households had access to credit services. The rest majority (80.1%) of sample households had no access to credit services. From the total sampled households, only 19.9% of the food secure and 19.8% of the food insecure households had received credit in the last three years. The result of the study indicates that food secure households received more credit than food insecure households. Moreover, as indicated below in table 12, the Pearson chi-square statistics is 34.3 with 1 degrees of freedom and a 2-sided p-value of p= 0.67 > 0.05, there was no significant difference in access to credit between food secure and food insecure households. Hence it can be inferred that access to credit service has no significant effect on household food security in the study area. Furthermore, information from the key informants and the focus group discussion participants' result shown us, the farming community was found indifference on the effect of credit access on food security.

Table 12: Access to Credit services for sample respondents

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Have you Received Credit?							
No	193	80.1	73	80.2	266	80.1	
Yes	48	19.9	18	19.8	66	19.9	34.3***

*** 0.001 % level of significance

Source: Own Survey Result, 2019

4.11. Food Aid

The survey results in Table 13 below shows that out of the total sampled households only 7.0% of households had received food aid. On the other hand, 12.1% of food insecure households had received food aid while only 3.7% of the food secure households received food aid. This indicates that food insecure households received more food aid than food secure households.

Moreover, as indicated below in table 13, the Pearson chi-square statistics is 8.142 with 1 degrees of freedom and a 2-sided p-value of p= 0.004 > 0.001. There was no significant difference in food aid between food secure and food insecure households. Hence it can be inferred that food aid has no significant effect on household food security in the study area.

Table 13: Food Aid for sample respondents

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		X^2
	Frequency	%	Frequency	%	Frequency	%	
Did you Received Food Aid?							
Yes	9	3.7	11	12.1	20	7.0	
No	232	96.3	80	87.9	312	93.0	8.142***

*** 1 % level of significance

Source: Own Survey Result, 2019

4.12. Age of household head

As table 14 below indicates the mean age of the sample household heads was 42.65 years with standard deviation of 13.25. Furthermore, the mean age of food insecure households was 43.43 years and that of food secure households was 42.36 years. Moreover, as indicated below in table 14, the t-value is 52.169 with 1 degrees of freedom and a 2-sided p-value of p=.001< 0.05. The significant value of t- test declares that the there is significant effect on food security status between samples that are aged above 64 and those 15-64. Hence it can be inferred that age of respondents has effect on food security status of households.

Table 14: Age of sample Respondent

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		t-value
Age of Sample Households							
Mean(SD)	42.36 (9.78)		43.43(9.39)		42.65(9.25)		52.169***

** 5% significant level

Source: own survey, 2019

4.13. Family Labor

Family size in adult equivalents indicates the sample household's average family labor force for agricultural production and other income-generating activities was 3.78 with standard deviation of 1.27. Besides, the result of the study shows that the mean labor of food secure and food insecure households were 3.97 and 3.23 respectively. Moreover, as indicated below in table 15, the t-value is 2.977 with 1 degrees of freedom and a 2-sided p-value of p= .002 < 0.05. This significant value of t- test testifies the existence of food security status gap between sample households with high labor force and those with small labor force. Hence it can be inferred that compared with household that have small labor force, households' that have many labor force are more food secured. Regarding to the influence of family labor on food security, data from key informants and focus group discussion reveals that the larger the family labors the more food secure households.

4.14. 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 who have age 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 is estimated to be 0.85, which means every 100 economically active persons, had 85 extra persons to feed, cloth, educate and medicate (table -15). Moreover, as it is revealed in the same table, the computed mean dependency ratio of food secure households was 0.65 with standard deviation of 0.25 and that of food insecure households was 1.39 with standard deviation of 1.93. Similarly, as indicated below in table 15, the t-test statistics is -5.302 with 1 degrees of freedom and a 2-sided p-value of p=

.03 < 0.05. This significant value of t- test signifies the existence of food security status disparity among samples that have many dependents and fewer dependents. Hence it can be inferred that compared with household with many dependents, household with fewer dependents are more food secured.

Table 15: Family labor and dependency ratio of Household Respondents

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		t-value
	Frequency	%	Frequency	%	Frequency	%	
Dependency Ratio Mean(SD)	0.65(0.25)		1.39(1.93)		0.85(1.08)		-5.302**
Family Labor Mean(SD)	3.97(1.19)		3.23(1.23)		3.78(1.27)		2.977**

, * at 5% level of significance respectively

Source: Survey Result, 2019

4.15. Households Land holding size

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 16, the average mean land holding in the study area was 1.13 hectares (ha) with standard deviation of 0.56. The survey result shows that 13.6% of total sampled households had 0.1-0.5 hectares of farmland, 50% of the total sample households had 0.51-1 hectares of farmland while 30.7% of the total sampled households had 1.01-2 hectares of land. It was only about 5.7% of the total sampled households had 2.01- 5 hectares of land.

The mean land holding of food secure households was 1.28 hectares while food insecure households had 0.73 hectare. Moreover, as indicated below in table 16, the t-value is 37.227 with 1 degrees of freedom and a 2-sided p-value of p= .000< 0.001. This significant value of t-test shows the prevalence of food security status difference between samples that have higher land holding size and those with small land holding. Hence it can be inferred that compared with household that have small land holding size, household that have large farm size are more food

secured. Concerning the influence of land holding size on food security, data from key informants and focus group discussion disclose that the owners of large size farmland are more food secure households than owners of small farm size.

4.16. 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. The average size of livestock holding in tropical livestock unit (TLU) for the total sampled households was found to be 3.26 with standard deviation of 1.10. Average holdings for food secure and food insecure households were 3.43 and 2.81 TLU with standard deviation of 1.02 and 1.19 respectively (Table 16). 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. Moreover, contrary to t-test result data from the key informants and the focus group discussion participants' results shown us, the farming community believes that the higher the livestock number they possess the more food secure they become.

Table 16: Land Holding Size and Livestock Ownership of sample respondents

Variables	Food Secure N=241		Food Insecure N=91		Total N=332		t-value
	Frequency	%	Frequency	%	Frequency	%	
Land Holding Size of Sample Households							
0.1-0.5	3	1.25	42	46.2	45	13.6	
0.51-1.0	127	52.7	39	42.8	166	50.0	
1.01-2.0	92	38.2	10	11.0	102	30.7	37.227***
Above 2.01	19	7.9	0	0	19	5.7	

Mean(SD)	1.28(0.53)		0.73(0.44)		1.13(0.56)		
TLU Mean(SD)	3.43(1.02)		2.81(1.19)		3.26(1.10)		3.693**

*** At 1% level of significance respectively

Source: Survey Result, 2019

4. 3. Household Food Security Status of sample households

4.3.1. Household food security access scale

The categorical household food security status of sample households was determined 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 of the study shows that out of total sampled households 241(72.6%) of households were food secure and 91(27.4%) of households were food insecure. Moreover; Majority (88.4%) of irrigation user households were food secure, while the remaining 5.8%, 3.5%, and 2.3% of irrigation user households were mildly food insecure ,moderately food insecure and severely food insecure households respectively. On the other hand, out of total non-user households 67.2% were food secure, 10.5% were mildly food insecure while 13.8% of irrigation non-user were moderately food insecure and 8.5% of non-user were severely food insecure (table 17). This implies that irrigation user households are more food secure than irrigation non-user households. Moreover, as indicated in similar table, the Pearson chi-square statistics is 31.654 with 9 degrees of freedom and a 2-sided p-value of p=.001< 0.05, This significant value of chi-square test states the existence of food security status among samples. Hence it can be inferred that compared with household heads that are non-irrigation users, households' heads that use irrigation are more food secured. The above discussion is in line with information obtained from key informant interview and focus group discussion.

Table 17: Household Food Security Status

Household food security status	Irrigation Users N=86		Non-Irrigation Users N=246		Total N=332		X^2
	Freq.	%	Freq.	%	Freq.	%	
Severely Food Insecure	2	2.3	21	8.5	23	6.9	31.654**
Moderately Food Insecure	3	3.5	34	13.8	37	11.1	
Mildly Food Insecure	5	5.8	26	10.5	31	9.3	
Food Secure	76	88.4	165	67.2	241	72.7	
Total	86	100	246	100	332	100	

** Significant at the 5% level of significance

Source: Own survey result, 2019

4.3.2. Household Food Consumption Score

The data on food consumption of 332 households was collected for capturing the variety and frequency of different foods consumed over a 7-day recall period. Table 18 below shows that sample households' food security status using Food Consumption Score for both irrigation users and non-irrigation user households.

By using the Food Consumption Score cut-off (the scale is adopted from Food and Nutrition Technical Assistance (FANTA) Project, 2007), irrigation users with acceptable food consumption borderline consumption and poor food consumption score were 47.7%; 30.2% and 22.1% respectively. Contrary, out of the total non-user households 65.1%, 19.9% and 15% had

acceptable food consumption, borderline consumption and poor food consumption score respectively (table 18). As indicated in the same table a one-way ANOVA was performed to compare the impact of Household food Consumption Score on irrigators and non-irrigators. Household food Consumption Score was divided into three groups (Adequate Food consumption (>42), Borderline Food consumption (28.5-42) and Poor Food Consumption (>28)). The outcome variable was found to be normally distributed and equal variance are assumed based upon the result of levene's test (F (331) =0.413, P=0.662). There was a significant difference in food consumption score for three groups (F (2,331) =4.917, P=0.06). This significant value of F-test states the existence of household dietary diversity score variation among irrigation users and non-users. Hence it can be inferred that compared with irrigation non-user households, irrigation users' households are found to consume a diverse diet.

Table 18: Household Food Consumption Score

Household food Consumption Score	Irrigation Users N=86		Non-Irrigation Users N=246		ANOVA (p-value)
	Freq.	%	Freq.	%	
Adequate Food consumption (>42)	41	47.7	160	65.1	0.06**
Borderline Food consumption (28.5-42)	26	30.2	49	19.9	
Poor Food Consumption(>28)	19	22.1	37	15.0	
Total	86	100	246	100	
Mean	34.3		28.5		

**** Significant at the 5% level of significance**

Source: Survey Result, 2019

4.3.3. Household Dietary Diversity

Table 19 below shows that more than half (62%) of irrigation user households and 39.8% of irrigation non-users had reported to consume high dietary diversity of greater or equal to 6 food groups within 24 hours recall period prior to the survey. Furthermore, 24.7%and 34.1% irrigation users and irrigation non-users, respectively, had medium dietary diversity of 4-5 food groups. It is also found that only 13.3% of irrigation users had consumed low dietary diversity of less than 3 food groups as compared to 26.1% of non-irrigation users that consumed the same amount. The result of the study indicates 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. Moreover, as indicated below in table 19, a one-way ANOVA was performed to compare the impact of House Holds Dietary Diversity score on irrigation users and non-user household heads food security status. Households' dietary diversity Score was divided into three groups. The outcome variable was found to be normally distributed and equal variance are assumed based upon the result of levene's test (F (331) =2.457, P=0.087). There was a significant difference in household food dietary diversity for three groups (F (2,331) =9.152, P= 0.003). This significant value of F- test states the existence of food security disparity between irrigation users and non-users. Hence it can be inferred that compared with non-irrigator households, households that practice irrigation have higher food consumption score. Data gathered from the two kebele from key informant interview and focus group discussion shows that there is diverse dietary in households that use irrigation than irrigation non-users.

Table 19: Sample House Holds Dietary Diversity score

House hold Dietary Diversity	Irrigation Users N=86		Non-Irrigation Users N=246		ANOVA (p-value)
	Freq.	%	Freq.	%	
High(≥6 food groups)	53	62.0	98	39.8	0.003**
Medium(4-5 food groups)	21	24.7	84	34.1	
Low(≤3 food groups)	11	13.3	65	26.1	

Total	**86**	**100**	**246**	**100**	
Mean	**4.25**		**3.2**		

* Significant at the 5% level of significance

Source: Own survey result, 2019

4.3.4. Major Coping Mechanisms to Food Insecurity Sample Households

Households in the study area have various coping mechanisms during food shortage months. This includes: consumption of 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 20, of the sample food insecure households, consumption of less preferable food was adopted by 19.0% to cope with food insecurity. Reduction in the quality of food taken was adopted by 16.9% and reduction in the quantity of food in each meal was adopted by 14.8%. Reduction in number of meals was adopted by 22.6% 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 11.1% and it refers to reducing additional food for children during the food shortage time in order to handle the situation. The rest of coping mechanisms were skipped meals and skipped meals for the whole days were adopted by 9.6% and 6.0% respectively in order to cope with food insecurity. Data from Focus group discussion and key informant interview is in line with the above discussion.

Table 20: Coping Mechanisms Adopted by sample food insecure household respondents

Coping Mechanisms Adopted	Frequency	%
Consumed less prefer food	63	19.0
Reduction in number of meals	75	22.6
Reduction in the quantity at food each meal	49	14.8
Skipped meals	32	9.6
Skipped meals for a whole day	20	6.0

Reduction in the quality of food taken	56	16.9
Reduction in complementary food to children	37	11.1

Source: Own Survey Result, 2019

4.4. Determinant Factors that Affect the Household Food Security

Before starting to analyze the determinant factors of food security status using logit model it is better to test collinearity test. Multicollinearity refers to the situation in which the independent/predictor variables are highly correlated. In order to check if there is Multicollinearity among the variables, tolerance & variance inflation factor (VIF) values were examined. According to Pallant (2005), tolerance is an indicator of how much of the variability of the specified independent variable is not explained by another independent variable in the model and if its value is less than 0.1, it indicates that the multiple correlations with other variables is high, implying possibility of Multicollinearity. Whereas, VIF is the inverse of tolerance value (1 divided by tolerance). If VIF value is above 10, it signals chance of Multicollinearity. Accordingly, the result in Appendix 1 shows that there is no possibility of Multicollinearity among the variables in the model since all the tolerance values are above 0.1 and the corresponding VIF values are below 10. Therefore, for the current data Multicollinearity is not an issue.

Then, the logit model was employed to estimate the effects of the hypothesized independent variables on food security status of households. From the estimation result of the marginal effect of the logit model as indicated in table 21, the model estimated groups of food secure and food insecure households accurately.

The model revealed that only seven variables were found to significantly affect household food security out of the hypothesized twelve variables. Among the factors considered in the model educational level of household, land holding size, access to irrigation activities, household sex and family labor were found to significantly and positively affect household food security, whereas dependency ratio and household age were found to significantly and negatively affect household food security.

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 security decreases by a factor of 0.03 as the dependence ratio of household increase by one person. Household heads that have higher number productive age groups than the non-productive age groups, the probability of the household to be food secure would be high than that of lower number of productive age group. This result is in line with the findings of Epherm (2008).

As indicated in table 21 below, access to irrigation positively and significantly affected household food security at significance level of 1%. Holding other variables constant, Irrigation user households were more likely to be food secure compared to irrigation non-users by factors 4.826 times. 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 in line with the result of Sikwela (2008) and Fanadzo (2012).

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 19.305 (table 21). This implies educated people can more readily utilize new technologies. Thus, being educated reduces the chance of becoming food insecure, which makes them to have enough food compared to illiterate household heads. This result is consistent with the finding of Oluyole et al. (2009)

At significant level of 1%, cultivated land size owned by households positively affected household's food security. The land size of households increased by 1 hectare, probability of food secure was increased by factor 51.389, 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 crops 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).

Households' 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 household 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 15.4 while keeping all other variables constant. Household with large labor force where 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).

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

Among the demographic variables, household head sex appeared to be significant in determining household's food security status in the study area. This variable is significant at 5% significance level and positively associated with food security. It is interesting to note that within the sample, holding all other factors constant, male headed households are found more food secure than their female counterparts. This shows that those farmers with male sex are more likely to be food secure than female. Like this study the study by Dillon (2011) found that gender of the head is a variable that statistically and significantly explaining the participation in irrigated agriculture.

Table 21: Result of Econometric Analysis

Variables	B	Wald	Df	Sig.	Odd Ratio
ACCIRRI	1.574	12.807	1	.003**	4.826
HHEDUC	2.960	32.943	1	.01**	19.305
TLU	-.188	.091	1	.762	.828
PARTINONFAR	.755	3.347	1	.073	2.127
ACREDIT	.419	.651	1	.067	1.520
HHSEX	.979	1.094	1	.04**	.376
CONDAGE	.094	.030	1	.036	1.099
DEPRATIO	-3.492	14.578	1	.03**	.030
HEALTHSTA	-.408	.581	1	.079	.665
FOODRECV	.670	.351	1	.004	1.954
LANDHOLD	3.939	36.324	1	.000***	51.389
HHAGE	-.685	.946	1	.001**	1.984
HHFALO	.453	21.8	1	0.002**	15.4
Constant	-2.005	1.194	1	.274	.135
***** P<0.01 and ** P<0.05 and *P < 0.1**					

-2Log likelihood =169.395 LR chi2 (217.970)
Probability >chi2 = 0.0000 Pseudo R2= 0.699
Number of households = 332

Source: Own survey result, 2019

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

In attempts made to get answers for the research questions the following results were obtained and based on the findings the following conclusions were made: 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 72.6% of the households in the study area were food secure while 27.4% were food insecure. From the sample total irrigation user 88.0% households were food secure and 57.2% of irrigation non-user households were food secure. Household diet diversity and food consumption score between irrigators and non-irrigators had significant mean difference at 1% significant level.

The survey result, t-test results indicated that, irrigation user households were more food secure than non-user households in the study area. Thus, the food insecurity occurrences for 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.

Employing binary logistic regression model, the study further identified determinants of household food security. Accordingly, education level of household head, cultivated land holding size, access to irrigation, household sex and household family size (labor) were the major factors that significantly and positively influence household's food security. On the other hand, Dependency ratio and age of household head significantly and negatively affect household food security.

Therefore, it can be concluded that the small irrigation scheme brought positive impact on production, income and livestock resource and food security status of irrigation users. In addition to access to irrigation, household size, income, livestock holding, oxen ownership as well as farm size were the major factors that determine household food security in the study area. The study, therefore, concludes that the small irrigation scheme significantly contributed to household food security.

5.2. Recommendations

In the study area still there are many households which are not participating in small scale irrigation. Based on the above findings the following recommendations are given in order to improve household food security in the study area.

- 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, governmental and non- governmental organization should expand households' access to small-scale irrigation to improve food security situations of the households.

- Governmental and non-governmental organizations should convert traditional river diversion into modern small-scale irrigation in order to use the water efficiently and effectively and hence, increasing irrigation participation in the study area.

- Government organization should establish market linkage for the production which can increase the income and food diversity of the households.

- Household with the educated heads are better in food security status than households with uneducated heads in the study area. Therefore, it is recommended that the governmental and non-governmental organization should provide access to education and make the farmer training center (FTC) functional.

- Dependency ratio is found to influence negatively the household food security status in the study area. This implies that household with large inactive household size especially with high dependency ratio could not be able to meet the minimum daily requirement. Therefore, governmental and non-governmental organization should expand appropriate strategy on income generation and diversification of livelihood coupled with expansion of family planning program.

- Governmental and non-governmental organization should organize capacity-building activities to advance farmers' participation in small-scale irrigation and to upgrade their existing indigenous way of management system.

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Appendix 1: Questioner

Wollo University

The Impact of Small-Scale Irrigation on Household Food Security in Drought Prone Area of Wag Himera Zone: The Case of Abergelle Woreda

General Introduction

The main purpose of this questionnaire is to collect data about The Impact of Small-Scale Irrigation on Household Food Security in Drought Prone Area of Wag Himera Zone: The Case of Abergelle Woreda. This study is conducted for the partial fulfillment of the requirement for Degree of Master of Sciences (MSc.) in Sustainable Natural resource management. Hence, I strongly ensure you that the study is carried out only for academic purpose and the results will be reported in the aggregate way. Thus, your response will never be deployed for other purposes.

Dear informants, all your responses are highly important for the successful completion of the study. Accordingly, you are kindly requested to provide honest and sheer information for every issue of the questionnaire.

Thank you in advance for your time and effort!

Instruction for Enumerators

1. Explain briefly the purpose of the questionnaire to the respondents and acknowledge their help
2. Circle the answers among the alternative choices and clearly describe the opinion of respondents for open ended questions
3. Write yours and respondent's identifications

Identification

Household identification number_____Peasant Association_____

Enumerator's Code_____Date of Enumeration_____

Section 1:

Part I. General Information

1.1 Date of interview: Day _____ Month _____ Year _____

1.2 Name of kebele_____

1.3 Region: _____

1.4 Zone: _____

1.5 Woreda: _____

Demographic characteristics

Part I: Household Characteristics

2.1. Household head's Name: _____

2.2. Household ID _____

2.3. Household Characteristics: Please list all household member

2.4. Age _____

2.5. Sex A/ Male B/Female

2.6. Family Size of the household A/ 1-3 B/4-6 C/ >7

2.7. Marital status A/ Married B/ Single C/ Divorced D/ Widowed

2.5. Relationship to head of household

A/ Household head (HH) B/ Spouse C/ Son D/ Daughter E/ Brother or sister/Mother/Father F/ In-laws G/ Relatives H/ Hired helper I/ Other (specify) _____

2.5. Religion A/ Orthodox B/ Islam C/ Catholic D/ Protestant F/ Other

2.6. Educational status

A/ Illiterate B/ Church/mosque education C/ Adult literacy program D/ Elementary school F/ Junior complete G/ 10 complete H / 12 complete I/ College graduate J/ Other (specify)_____

Part II- Household land holding and crop production

2.12.1. Do you have your own agricultural land? A/ Yes B/ No

2.12.2. If your response is yes for Q (2.12.1.), what is the size of landholding of the household in hectare? A/ < 0.25 B/ 0.26-0.5 C/0.6-1 D/ 1.1-1.5

2.12.3. What is the distance of your cultivation field from your residence?

A/ <10 minutes' walk B/ 10 to 25 minutes' walk C/ 25 minutes to 1 hour walk

D/ 1to 1and 25 minutes' walk E/ >1and 25 hours

2.12.4. What is the Slope of the plot? A/ flat, B/ slight slope, C/ moderate slope, D/ steep slope

2.12.5. What is the Soil depth condition? A/ shallow, B/ medium, C/ deep

2.12.5. What is the Degree of erosion? A/ No erosion, B/ Less erosion; C/ Medium erosion; D/ High erosion; E/ extremely eroded, F/ other (specify)_____

2.12.6. Duo you have irrigated land? A/ Yes B/ No

2.12.7. What is the land tenure system? A/ own land B/ rented-in, C/ rented out, D/ other (specify) ----------

2.12.8. What type of crop does you grown

A/ teff, B/ wheat, C/ barley, D/ maize, E/ millet, F/ sorghum, G/ Sesame, H/lintels Bean I/field pea, J/ cheak pea, K/ Sorghum, L/ haricot bean, M/ Vegetables and tubers, N / Fruit trees (specify), O/ Fallowing P/ other (specify).

2.12.9. If not cultivated what is the type land use?

A/ restricted grazing, B/ non-restricted grazing, C/ forest/woodlot, D/ Bush/shrubs, E/ other (specify)----------

2.12.10. What is the main reason for not cultivating?

A/ fertility decline /for fallowing purpose, B/ lack of oxen for cultivation, C/ unable to afford fertilizer inputs, D/ Others, (specify) ----------

2.12.11. Do you hire labor for cultivation? If yes A/ No Male ---------- B/ No Female ----------

2.12.12. What is the average daily price for labor? A/ for male----------B/ For Female----------

2.2. Fertilizer use, crop management and output

2.2.1 Do you have own oxen for plowing/ cultivation? If yes how many have you?

A/ 1 B/ 2 C/3 D/4 E/ 5 F/>6

2.2.2. If not, what price do you pay for day?

A/ 20 B/50 C/ 75 D/ 100 E/ >100

2.2.3. What type of seed do you used? A/ Local B/ Improved

2.2.4. What amount seed do you used?

A/ 10-20 kg B/ 30-40 kg C/50- 60 kg

D/ 70-80 kg E/ 90-100 F/ >100 kg

2.2.5. How much is the price of seed in KG?

A/ 5-10-birr B/ 15-20-birr C/ 25-30-birr D / 35 -40 Birr

E/ 45-50-birr F/ other specify ----------

2.2.6. Where is the source of seed?

A/ Own, B/ Neighbor, C/ Open market, D/ Cooperatives/union, E/ Service cooperatives, F/ other (specify)

2.2.7. Do you use organic fertilizer? A/ Yes B/ No if not skip question 2.2.8

2.2.8. Where is the source of compost/ manure? A/ own, B/ neighbor

2.2.9. What is Input source for compost making?

A/ crop residues (specify), B/ tree leaves (specify), C/ animal dung,

D/ Combination of these inputs, E/ other (specify)'

2.2.10. Do you used in organic fertilizer? A/ Yes B/ No if the answer is no skip question

2.2.11. What type of fertilizers do you used? A/ Dap, B/ URE

2.2.12. What is the price of inorganic fertilizers for KG? A/ Dap ------birr B/ URE------- birr

2.2.13 Where is the source of fertilizers?

A/ Neighbor, B/ Open market, C/ Cooperatives/union,

D/Service cooperative E/ Other (specify)

2.2.13. Do you use pesticide/insecticide? A/ Yes B/ No if the answer is no skip question 2.2.14

2.2.14. What amount of pesticide do you used (in KG)? ----------

2.2.15. How much price do you pay for pesticide /in kg/? ----------

2.2.16. What amount of insecticide do you used (in KG)? ----------

2.2.17 How much price do you pay for insecticide /in kg/? ----------

2.2.18 Do you have other expense? ----------

2.2.19. What is the total o output quantity (Kg) ----------?

2.2.20. Quantity sold (in Kg)? ----------

2.2.21. What is the Sell price/kg/----------?

2.2.22. Where is Place of sell?

A/ farm gate, B/ market in the PA, C/ Market in the district capital,

D/ Market at zonal capital, E/ Market at the regional capital, F/ other, (specify)

2.2.23. Sold to whom?

A/Farmers, B/Assembler/broker, C/Wholesalers,

D/ Retailer, E/ Service cooperatives/union, F/ Consumers, G/ Other,(specify

2.2.24. What is distance to the major market (in k m) ----------

2.2.25. What is the transportation mechanism?

A/ walk B/ animal pack c/ vehicle D/ local Boat E/ other specify ----------

2.2.26. What amount of cost you pay for transport (in Birr) ----------?

2.3. Livestock holding

2.3.1. Do you have own livestock? A/ Yes B/ No if the answer is no skip question 2.3.2

2.3.2. What type of Livestock do you have?

A/Oxen B/ Cows C/ Calves D/ Heifers E/ Sheep

F/ Goats G/ Chicken H. Horse I/ Mule J/. Donkey K/ Camel

2.3.3. How much livestock owned during last year?

A/Oxen-------- B/ Cows------ C/ Calves---------D/ Heifers-------- E/ Sheep----------

F/ Goats --------- G/ Chicken-------- H. Horse------- I/ Mule --------J/. Donkey--------
K/ Camel ---------- 13. Others----------

2.3.4. How much of livestock died during last year ?

A/Oxen--------- B/ Cows---------- C/ Calves---------- D/ Heifers--------

E/ Sheep---------- F/ Goats --------- G/ Chicken-------- H Horse-------

I/ Mule ---------- J/. Donkey--------- K/ Camel ---------- 13. Others----------

2.3.5.How much of livestock bought during last year?

A/Oxen--------- B/ Cows---------- C/ Calves--------- D/ Heifers-------- E/ Sheep----
F/ Goats --------- G/ Chicken-------- H Horse------- I/ Mule ----------
J/. Donkey-- K/ Camel ---------- 13. Others----------

2.3.6. How much of livestock sold during last year?

A/Oxen--------- B/ Cows---------- C/ Calves---------- D/ Heifers--------

E/ Sheep---------- F/ Goats --------- G/ Chicken------ H Horse-------

I/ Mule ---------- J/. Donkey--------- K/ Camel ---------- 13. Others----------

2.3.7. What is the total value in birr ----------

Part III- Questionnaires related to determinant factor that affects the household food security

2.4. Health-related factors

2.4.1 .last year anybody in your household is sick? A/ Yes B/ No

2.4. 2. Which of the following places do you first contact for a solution?

A/ Clinic/Hospital B/ Dispensary C/ Traditional healer D/Spiritualists E/ Others specify

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

Institutional factor

2.5. Access to credit

2.5.1. Have you over the last 3 years received credit? A/ Yes B/ No if no skip below question

2.5.2. For what purpose do you receive the loan A/ Non-agricultural Investments B/ Consumption loans C/ Family events D/ Other, specify----------

2.5.3. How much amount of birr do you received as credit ----------?

2.5.4. Where is the source of credit? A/ Bank, B/ microfinance institution, C/ Neighbor/relatives, D/ Association/equip, E/ Others

2.5. 5. If you want, are you able to obtain credit?

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						

Physical factors

2.6. Agricultural Extension

2.6.1. Is there farmers training center (FTC) in your kebele? A/ Yes B/ No

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

2.6.3. Do you contact with DA/ Development agent? A/ Yes B/ No

2.6.4. If yes when you contact with DA per month?

A/ One times B/ Two times C/ More than two times

Part IV- Questionnaires elated to household food security situation

2.7. In which Income generating sources do you participate?

A/ Farming B/ Civil Servant C/ Housewife D/ Daily laborer

E/ PA/village official F/ Hand craft G/ Herder H/ Stone/sand mining and sale I/ Trader J/ Other (specify

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

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

A/ Yes B/ No

2.7.3. If your answer for question number 2.7.2. Is yes, what were the possible causes for this problem of crop failure last year?

A/ Water shortage B/ Damaged by disease C/ Poor adaptation of varieties used D/ Poor administration of water distribution E/ Others specify

2.7.4. What is the source of water for your irrigation?

A/ Rivers B/ Springs C/ Ponds D/ Well E/ Other, specify _____

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

2.7.6. If no use irrigation, why not you use irrigation technology?

A/ Distance of water to farmland B/ Lack of farmland

C/ Cost of irrigation materials D/ Overall cost of technology

2.7.7. Are you supported by Livestock and Irrigation value chains for Ethiopian smallholders (LIVES) project? A/ No B/ Yes

2.7.8. If the answer is yes to Q. 2.7.7, what benefits did you get from this project?

A/ Exposure for improved technology B/ Exposure for improved practices (practical lessons) C/ Demonstration to applicable technologies D/ Market networking,

E/ Production and post-production advice, F/ Other, specify

2.7.9. Is there any change on household food security and production after the support by LIVES project? A/ Yes B/ No

2.7.10. If the answer is yes to Q. 2.7.9, what is the change?

A/ Improved household food security B/ Increase the productivity

C/ Create opportunity for non- employment D/ Reduced dependency

2.8. Off/non-farm income

2.8. What special skill do you have?

A/ No special skill B/. Mason C/ Trader/merchant

D/ Handicraft E/ Carpenter F/ Traditional healer G/ Other (specify)

2.8.1. Have you any one-person member of household participate in off farm income generating activity? A/ Yes B/ No if the answer is no skip the next question.

2.8.2. In which activity do you engage?

A/ Food for work B/ Cash for work C/ Hire out labor D/ Part time job E/ Remittance income F/ Food aid G/ Self- employment

H/ Sale of firewood I/ sale of handicraft J/ sale of beverages

K/ Chat trading L/ Other petty trade and M/ Village shop

2.8.3. How many / number of months/ days' work per year----------?

2.8.4. What is the amount of wage (cash) for day in birr ----------?

2.8.5. What is the amount of wage (kind) for day in birr ----------?

2.8.6. Amount of total income earned in the year ----------?

2.9. Food Aid

2.9.1. Have you received any aid in the last year? A/ Yes B/ No

2.9.2. If yes to question 2.9.1, please indicate the type and amount receive

Type of aid items received	Amount of Aid Received per month	Unit price	Total income received
Wheat			
Cash			
Vegetable Oil			
Y.S.P(yellow split pea)			
Other			
Total			

Part V- Questionnaires related to household food consumption

2.1. Household food security

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.

2.1.1. Number of food servings per day (First check the composition of the household members in the household)

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

2.1.2. Did your household face food shortages in the last 5 years? A/ Yes B/ No (If the answer is no skip to 3.1.3.)

2.1.3. If yes to Q.3. 1.3, how often has the household faced food shortages? _____

A/ Sometimes (once in 5 years), B/ Often (2-3 times in 5 years), C/ Very often (3-4 times in 5 years), D/Always (continuous/chronic problem)

2.1.4. When is food shortage more serious in the household?

A/ Kiremt (June to August).B/ Meher (Sept. to November), C/ Bega (December to February), D/ Tseday (March to May)

2.1.5. How does food shortage affect household consumption? Rank 1 to 4

A/ Never, B/ rarely (once), C/ From time to time (2 or 3 times)

D/ Often (5 or more times) if there is change because of food shortage

2.1.6. Household food consumption status in the last seven days.

A/ Never, B/ Rarely (once), C/ From time to time (2 or 3 times)

D/ Often (5 or more times) if there is change because of food shortage

Effects	3.1.6. Overall Rank for Household	3.1.7. under 5 Children	Adolescent (10 – 19 years)		Adult (> = 20 years)	
			3.1.8 Girls	3.1.9. Boys	3.1.10 Female/ Mother s	3.1.11 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						

Part VI - **Questionnaires related to household deity diversity**

NO	Food items	Yes	No
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		
1	Any sugar or honey?		
12	Any other foods, such as condiments, coffee, tea?		

3.1. Household dietary diversity (HDD) score questionnaire

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	fish Any beef, lamb, goat, chicken, liver, kidney, heart, or other organ meat								
	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								

Appendix 2: Total Livestock Conversion factors

Livestock Category	TLU
calf	0.34
Heifer	0.75
Cow and Ox	1.0
Horse	1.1
Donkey	0.7
Sheep and goat (adult)	0.13
Chicken	0.013

Source: Storck*et al.,* 1991

Appendix 3: Conversion factor for Adult equivalent

Years of age	Men	Women
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78

Appendix 4: The Regression coefficient of factors affecting food security status

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Multi-Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	.275	.105		2.616	.009		
Irrigation Users and Non-Irrigation Users	-.440	.032	-.493	-13.636	.000	.830	1.205
Education Level	.334	.038	.307	8.797	.000	.891	1.122
Access to Irrigation	.187	.033	.207	5.620	.000	.798	1.253
Health Status	-.122	.038	-.109	-3.199	.002	.929	1.076
Frequency of Contacts with DA	-.024	.023	-.037	-1.070	.286	.931	1.074
Participation in Non-farm activities	.079	.030	.089	2.652	.008	.971	1.030
Credit Received	.039	.038	.035	1.051	.294	.963	1.038
Land Holding Size	.170	.028	.214	6.055	.000	.865	1.156
Age	-.001	.001	-.028	-.821	.412	.928	1.078
TLUU	.065	.014	.161	4.724	.000	.936	1.069
Sex	-.215	.073	-.150	-2.957	.003	.421	2.374
Food Aid	.138	.091	.074	1.517	.130	.458	2.182

Dependent Variable: food security status