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COLLEGE OF DEVELOPMENT STUDIES

FOOD SECURITY AND DEVELOPMENT STUDIES

ASSESSMENT OF SMALL SCALE IRRIGATION CONTRIBUTION TO HOUSEHOLD FOOD SECURITY IN ANGOLELA TERA DISTRICT, NORTH SHOA ZONE OF AMHARA NATIONAL REGIONAL STATE, ETHIOPIA

BY

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LIST OF ACRONYMS

ACSI	Amhara Credit and Saving Institution
ADLI	Agricultural Led to Industrialization
ANRS	Amhara National Regional State
BOARD	Bureau of Agriculture and Development
BOWRD	Bureau of Water Resource Development
CIAT	Centre for International Tropical Agriculture
CSA	Central Static Authority
DA	Development Agent
ETB	Ethiopia Currency Birr
FCS	Food Consumption Score
FSN	Food Security and Nutrition
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institutes
HICE	Household Income Consumption Expense
HLPE	High-Level Panel of Experts
IWMI	International Water Management Institute
MOARD	Ministry of Agriculture and Rural Development
MOFED	Ministry of Finance and Economic Development
MOWE	Ministry of Water and Energy
NBDC	Nile base development challenge

PASDEP	Plan of Accelerated and Sustainable Development Eradicate Poverty
PSNP	Productive Safety Net Program
SSI	Small Scale Irrigation
WRIMP	International Water Management Institute

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Assessment of Small Scale Irrigation Contribution to Households' Food Security in Case of Angolela Tera District, North Shoa Zone Amhara, National Regional state, Ethiopia

By: NIBRET YITBAREK

ABSTRACT

Ethiopia has been highly affected by drought and climate-related hazards, and millions of people have been left without sustenance every year. Irrigation is one means through which agricultural production and farm income can be increased to meet the growing food demands of the world. This study focused the assessment of small scale irrigation contribution to households' food security in case of Angolela Tera district North Shoa zone, Amhara National Regional state.

This study investigates the contribution of small-scale irrigation to the households' food security status. Both primary and secondary data were collected for the study. Primary data were collected from 140 sample households drawn from beneficiary households by systematic random sampling method, focus group discussion (25irrigation farmers); key informant interview, and direct personal observation were also used to collect qualitative data. Both correlation and descriptive statistics were used to describe the association of the sample households-in small scale irrigation. To get the food security status of households, a modified form of a simple equation termed as food consumption score, dietary diversity originally from FAO was applied. The findings of the study highlights that there is a positive impact of irrigation because it brings increased agricultural production and productivity, which in a way improves food security situation asset building. Regarding food security, irrigation users are in a better position in food access, utilization and availability and also in a better position in dietary frequency and diversity , Based on the result some of the factors affecting small scale irrigation were found to be the skill gap in utilization of irrigation agronomy, instability of the market, lack of access market information ,pest and diseases It has been, therefore, concluded that small scale irrigation development contributes to food security of beneficiary households. Thus, ministry of agriculture and non-governmental organizations should join hands to support the development of such small scale irrigation schemes. Linking the farmers with the marketing system, training on irrigation agronomy, and making the users aware of effective and efficient utilization of water irrigation management, promotion of

post-harvest technology, access technology has small scale irrigation schemes could significantly improve the status of food security.

Key words .Small scale irrigation, house hold food security, and dietary diversity.

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Ethiopia is the second-most populous country in Africa. The incidence of poverty stands at 30% at the national level. The incidence of poverty is higher for rural areas than urban areas at 33% and 29%, respectively (Eshetu, 2017). Agriculture plays an important role in the development of the national economy, contributing about 50% of the gross domestic product (GDP, and employs 85 % of the population (FAO, 2012). Combinations of natural and manmade factors have resulted in serious and growing food insecurity problem in many parts of the country. Currently, about fifteen million people are facing food insecurity, either chronic or transitory. About five to six million people are chronically food insecure every year. Some people cannot produce or buy enough food to meet their annual food needs even under normal weather and market conditions. The remaining ten million are vulnerable, with a weak resilience to any shock. Under any emergency circumstances, the likelihood of these people falling back into food insecurity is high (FAO, 2012).

TO address food insecurity of the rapidly growing population in Ethiopia, the current agricultural area assumed to increase by 25%, while average yields are assumed to increase by one-half by 2020. Food insecurity often turns into famine with the slightest adverse climactic incident. The challenge, therefore, is how to meet the increasing demand given the existing but declining natural resources and worsening climatic conditions. Hence, there should be ways to use improved technologies of agricultural production to enhance the economic, social, and institutional conditions necessary for increased agricultural production and productivity.

The country may not be able to meet its large food-deficit through rain-fed agriculture alone

Irrigation development has been given priority in the Agricultural development led industrialization (ADLI) strategy of Ethiopia. Under the program, irrigation is planned to be

introduced and implemented in areas where agro-ecological conditions are in harmony with the interventions (GOE, 2001). On top of this, the Ethiopian government, in collaboration with its development partners, has developed a food security program me (FSP) within the framework of the plan for accelerated and sustained development to eradicate poverty (Pasdep), which is a guiding strategic framework for the five years 2005 to 2010. In the Pasdep and the Fsp, due emphasis has been given to developing and using the huge potential of the country for irrigated agriculture to produce food crops as well as raw materials needed for agro-industries (Fao, 2006).

Irrigation development is being promoted by government and non-government organizations as one of the development strategies contributing to the overall agricultural development of the country in general, and rural household food security in particular. Though, irrigated agriculture has a positive impact on household food security and income (Fuad, 2002; Desta, 2004, cited by Girma, 2011). There are cases where irrigated agriculture failed to achieve the intended impact on the household's well-being. The contribution of farmer-based small-scale irrigation for semi-cash cropping has not been studied, though such schemes cover more than 40% of the irrigated land in the country (Dessalegn, 1999). Seleshi et al. (2005). Indicated the need for undertaking impact assessment of small-scale irrigation particularly on the production and productivity of rural households.

Study mainly focus the assessment of small scale irrigation contribution of house holds' food security the case of Angolela Tera district, The main source of livelihood for the population is mixed agriculture. About 98% of the population in the *Woreda* depends on agriculture for their livelihood. Most of the people depend on the main rainy season for their annual crop production. Perennial and seasonal springs are found in most of the rural *kebele* administrations and they are mostly used for traditional irrigation practices, animal and human consumptions *(*Woreda Moa, 2019). The total area of the *district* is 98,900 hectares of which 1602 ha is irrigable and 1576 ha is already irrigated.therefore, district has a great potential for small-scale irrigation. It is one of the chronically food insecure areas in Amhara National Regional State and is among the 52 vulnerable districts that are targeted by the Regional food Security programs (BoARD). The district has been repeatedly hit by drought due to the insufficient and erratic nature of rainfall. In this respect, water use for agriculture by smallholder farmers is an appropriate choice.

The main motivation behind this study to explore whether irrigation access, availability and utilization of food in the study area is making positive change on household food security or not.

1.2. **Statement of the Problem**

The population of the country is increasing at a rate of about 2.9 percent per annum, while its annual agricultural growth is 2.4 percent. (Fasil, 2007). The agricultural performance in the country has not exceeded the population growth over the past four decades, and the gap between food needs and availability has continued to widen, requiring additional food. Food aid has accounted for most grain imports in Ethiopia over the last few decades. Food aid flows to Ethiopia (including local procurement) averaged 728 thousand tons since 1990 and has ranged from 120 thousand tons in 1996 to 1.22 million tons (ten times the 1996 total) in 2002. Most of this food aid was in the form of cereal (almost all wheat) imports, which accounted for almost 10 % of total cereal availability. In Ethiopia, food production and supply show substantial geographical differences; there are surplus producing areas (mostly in the central highlands) and chronic food insecure regions (a particular feature of the north, north-east, east and far south of the country). Both acute and chronic food deficits are linked in Ethiopia; consequently, 15 percent of the population lives in conditions highly vulnerable to drought and other shocks. (Medrek, 2004, cited by *Fasil,* 2007).

The 1995/96 and 1999/00 household income consumption expenditure and welfare monitoring surveys indicated that about 44 percent of the population of Ethiopia live under absolute poverty. As a consequence, about 51 percent of Ethiopians are considered food insecure and malnourished, and 27 percent of the population lives under conditions of extreme food poverty, unable to consume more than 1.650 calories per day. 6-7 million people are chronically food insecure, lacking sufficient resources to consume enough food even in good years since the world first found out about the disaster caused by famine and drought in Ethiopia in 1974, the country has become one of the main recipients of international food aid. The majority of farmers do not produce enough to cover their minimum subsistence needs. Crop yields are low even in years of good harvests,/ Irrigation development and management is one of the effective approaches to settle such food shortage and to contribute toward attaining food security (Wrimp, *2014*).

Although the country has 4.5 million ha of irrigable land, irrigation covers only 0.16 million ha or about 5% of the total irrigable land. The dependence of most of the farmers on rain-fed agriculture has made the country's agricultural economy extremely fragile and vulnerable to the impacts of weather and climatic variability leading to partial or total crop failure, which in turn resulted in food shortages (MoWE , 2011).

Amhara region is endowed with a potential irrigable land area of 0.6 million ha (3.9%) out of the total landmass of 15.5 million hectares within the four major river basins (Abay, Awash, and Tekeze- Angereb river basins and Afar drainage basin). (Awulachew et al., 2005; Bowrd, 2005). Also, it enjoys the considerable potential for surface water harvesting by small-scale dams and river diversions and also underground water resources. However, the total area under irrigation to date amounts only to about 76 thousand ha, this is less than 2% of the total cultivated land in the region (Bowrd, 2005).

Researches on the contribution of small scale irrigation rural farm households are not extensive in the study area. in the north Shoa zone, where this study was conducted, studies are scanty and there are no published works on the factors that the assessment of small scale irrigation contribution of household food security .The main motivation behind this study to explore whether irrigation access, availability and utilization of food in the study area is making positive change on household food security or not related to small scale irrigation intervention.

1.3. Objective of the Study

1.3.1. The Main Objective of the Study

The main objective of the study is to investigate the contribution of small-scale irrigation to the household food security of Angolela Tera woreda, North Shoa zone of Amhara regional state.

1.3.2. Specific Objectives of the Study

I) Analyze the contribution of small-scale irrigation on food security of the rural household

ii) Analyze issues that enhance or impede small-scale irrigation capacities in the target areas.

iii) To determine the strategies that can promote small scale farmers in improving production through Bura Irrigation scheme.

1.4. Significance of Study

The study give clue for policymakers and planners towards major bottlenecks of poor farm.

The study is significant for it increases individuals' understanding regarding the factors that contribute to food security household's participation in small-scale irrigation.

Research on issues concerning it provides additional information and understanding to local conditions through cooperatives' marketing linkage to their products at the appropriate price. Households' association of small-scale irrigation in the study area. The study result might also be used as a reference and initiate other researchers who are interested in conducting different research works from different perspectives on the field which improves the performance of the dominant sector.

1.5. Scope and Limitation

The study focused on the assessment contribution of small-scale irrigation to rural household food security. This study has limited to Bura Totose irrigation schemes which are located in one kebele namely Bura Totose in Angolela Tera woreda, Amhara Region. Because of the limit time, budget constraint, first the study will be undertaken in one district that could not allow generalizing the whole Amhara region, second, the period of one year was relatively short to investigate and understood the contribution of small-scale irrigation schemes to households' crop agricultural products and food security. Third, small scale irrigation schemes couldn't irrigate the entire landholding of irrigation user farmers, therefore, irrigation-user farmers are engaged in irrigating as well as rain-fed agriculture, fourth the other food-insecure kebele difficult to engage in research due to their difficulty land escape and potential. Despite this, great care had taken to maintain the representativeness of the sample size by ensuring that the selected sample households and *kebele* are representing the study area, and the reliability and validity of the research results by making use of a combination of various research methods.

1.6. Organization of the Thesis

This thesis has been structured into five chapters. Chapter one is an introduction and it covers the background of the study, statement of the problem, objectives of the study, the significance of the study, scope, and limitation of study and organization of the thesis. Chapter two presented the literature review and information on the previous works and empirical findings have been properly

out and entertained. Chapter three presents the data source, methodology. In this chapter, the description of the study area, the sources of data, the methods used to obtain the data, and the theoretical and correlation used to analyze the data set are presented. Chapter four given the investigation and interpretation of descriptive and correlation analysis. Finally, conclusions drawn from the analysis of the data and policy implications as well as recommendations are given in chapter five.

CHAPTER TWO

2. LITERATURE REVIEW

In this part, this study outlines both theoretical and empirical evidence that would enable the researcher to estimate the magnitude and direction of explanatory variables quantitatively and to interpret the scheme contribution on household food security. In light of this different literatures have been organized based on sequential, topical, methodological, and theoretical that has already studied. theoretical (definition of concepts/ food security, the concept of irrigation and irrigation development) and empirical works of literature in connection with identifying strategies that have been attempted, results obtained, gaps or shortfalls of past studies and refining, revising and extending this research to some extent is the supportive reviews of this task.

2.1. Concepts and Definition of Food Security

The world food conference defined food security in terms of the food supply in 1974. At the 1996 world food summit, 182 nations agreed on the definition as physical and economic access by all people at all times to sufficient, safe, nutritious food, and dietary food preference for an active and healthy life. This definition has four pillars (food availability, accessibility, utilization, and stability). This enables to set threshold and distinguish food security from food insecurity situations.

Food **availability** refers to sufficient quantities of food with appropriate quality supplied through domestic production or imports including food aid.

Food **access** is the presence of adequate resources to acquire appropriate foods for a nutritious diet. It is an entitlement or command over the food supplied.

The utilization of food is to meet an adequate diet, clean water, sanitation, and health care to search for a state of nutritional well-being. It is about the cultural acceptability of the food in the local communities.

The stability of food refers to the level of resilience to shocks and other crises. Thus, the concept of food security consists of food and non-food inputs and can attain the fulfilment of the above four food security elements.

2.1.1. Food Security Situation in Ethiopia

Food insecurity and famine in Ethiopia are the results of erratic and low rainfall .Ethiopia faced three large-scale drought-induced food shortages and famines in recent history, i.e. in 1972/73, 1983/84, 2002/03, which cost many lives (Awulachew et al, 2005). In 2002/03 15 million people (over 20% of the population) received food aid. Population increase, deforestation, and frequent land distribution have affected agricultural production in Ethiopia.

This is reflected in a decrease in household production, grazing land, and scarcity of manure. In 2006 for instance, about fifteen million people are facing food insecurity that is either chronic or transitory. About five to six million people are chronically food insecure every year. Some people cannot produce or buy enough to meet their annual food needs even under normal weather and market conditions. The remaining ten million are vulnerable, with a weak resilience to any shock (FAO, 2006).

2.1.2 Household Food Security indicators

Ethiopian economy has grown and food security has significantly improved over the past two decades. Agricultural growth has been a key part of this progress and will need to be maintained if the country is to build on this past success and sustain rapid overall growth while sharply reducing poverty in both rural and urban areas. Research into agriculture and food security can further this objective by informing effective policymaking in the five areas identified above. Successful policy will not only avoid large-scale famines if and when major production shortfalls occur but will also lead to sustained improvements in food availability, access, and nutrition at the national and household levels. Ethiopia has made considerable progress toward food security since the 1984 famine captured worldwide media attention. Almost 30 years after that calamity, Ethiopian per capita income has increased, poverty has fallen, food security has improved, and the groundwork has been laid for sustained economic growth (Paul *et al*., 2013).

The same source indicated, providing effective safety net, increasing food security for many asset-poor households requires effective disaster response policy and safety nets. Successful responses to past food emergencies have included early warning systems, well-managed grain reserves, and distribution of food and cash in ongoing safety-net programs. The Productive Safety Net Program me (PSNP), introduced in 2005 as an alternative to annual emergency-food-aid distribution, has proven very effective in targeting poor households with food and cash transfers, as well as building local infrastructure through a work requirement for those recipients who are able to work. Econometric estimates derived from household surveys indicate that households in the poorest 40

percent of the household expenditure distribution receive more than 60 percent of total PSNP transfers. Research has also shown that programs to offer credit, skills training, and other services have been effective as complements to cash and food transfers in building participant households' assets and livelihoods.

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

Different types of indicators, however, fall under two main categories; 'process' and ' outcome' indicators. Process indicators provide an estimate of food supply and food access situation whereas outcome indicators serve as proxies for food consumption.

2.1.3 Process indicators

Process indicators are those indicators that provide an estimation of food supply and access situation. These indicators in turn can be divided into two: those indicative and healthy. The availability and accessibility of food to meet individual food needs should also be sustainable. This implies that early warning systems of food insecurity should monitor indicators related to food production, distribution, and consumption. Among the various definitions of household food security, the focus in household food security is on how members of a household produce or acquire food throughout the year, how they store, process and preserve their food to overcome seasonal shortages or improve the quality and safety of their food supply. Household food security is also concerned with food distribution within the household and priorities related to food production, acquisition, utilization and consumption

2.1.4 Outcome Indicators

We use these indicators to measure the status of food security at a given point in time. Often, household food security outcome indicators can be categorized into direct and indirect indicators. As far as direct indicators of food consumption is concerned, they include those indicators which are closest to actual food consumption rather than to marketing channel information or medical status. Unavailability or high cost of direct measure in terms of money and time leads to application of indirect indicators to collect the data. Of the direct indicators, household budget and consumption surveys, household perception of food security and food frequency assessment are the major ones whereas storage estimates, subsistence potential ration and nutritional status assessment are incorporated in indirect indicators (Maxwell and Frankerberger, 1992).

2.1.5 Concepts and Definition

According to (FAO, 1997) **irrigation** is "the supply of water to crops by artificial means, designed to permit farming in arid regions and to offset the effect of drought in the semi-arid region" irrigation as the cultivation of land through the artificial application of water to ensure double cropping as well as a steady supply of water in areas where rainfall is unreliable. Irrigation water is applied to ensure that soil moisture is sufficient to meet crop water needs and thus reduce water deficit as a limiting factor in plant growth. Irrigation is generally defined as the application of water to the land to supply moisture essential to plant growth, and also intended to augment the water supply from rainfall.

Household: is defined in this research as people living under the same roof and eating food from the same pot. That is a household member who did not live independently during the survey time at least for one year.

Rural: is any locality that exists primarily to serve agricultural hinterland.

Rural farm household: is a household that lives in the countryside and that may involve in farm activities.

Woreda: is an administrative unit greater than kebele and equivalent to the district.

Kebele: is the lowest administrative unit of settled rural areas.

2.1.6 Overview of Ethiopian Irrigation

Ethiopia comprises 112 million hectares (m ha) of land. Cultivable land area estimates vary between 30 to 70 m ha. Currently, high estimates show that only 15 million ha of land is under cultivation, for the existing cultivated area, we estimate that only about 5 percent is irrigated, with existing equipped irrigation schemes covering about 640,000 hectares. This means that a significant portion of cultivated land in Ethiopia is currently not irrigated. This section examines Ethiopia's water sources for irrigation, current irrigation schemes, and the potential to increase irrigated lands. Our premise is that well-managed irrigation development is key in helping Ethiopia overcome major challenges including population pressure; soil and land degradation; high climate variability, and low agricultural productivity. Besides, agricultural water development is crucial to improve smallholder livelihood and income in Ethiopia, since irrigation can help farmers increase their crop production, increase crop variety, and lengthen their agricultural seasons. As explained in subsequent sections, million households (~30 million direct beneficiaries).(Awulachew, 2010).

The development of irrigation and agricultural water management holds significant potential to improve productivity and reduce vulnerability to climatic volatility in any country. Although Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation. The majority of rural dwellers in Ethiopia are among the poorest in the country, with limited access to agricultural technology, limited possibilities to diversify agricultural production given underdeveloped rural infrastructure, and little to no access to agricultural markets and technological innovations. These issues combined with increasing degradation of the natural resource base, especially in the highlands, aggravate the incidence of poverty and food insecurity in rural areas. Improved water management for agriculture has many potential benefits in efforts to reduce vulnerability and improve productivity. Specifically primary rationales for developing the irrigation sector in Ethiopia include, increased productivity of land and labor, which is especially pertinent given future constraints from population growth, reduced reliance on rainfall, thereby mitigating vulnerability to variability in rainfall.

2.1.7 Contribution of Irrigation to Household Income

Irrigation has high contributions to food security, asset ownership, and income of rural households. Increased in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health due to balanced diet and easy access and utilization for medication, soil and ecology degradation prevention and asset ownership are a few to mentioned (Kalkidan et al., 2017). Most of the time, irrigation utilization greatly supports the livelihood of the non-irrigation users through employment opportunities. Irrigation users invest the additional income gained from irrigation in different activities, some irrigation users provide in community services, while others in educating their children. Besides, increasing income from irrigation made them access materials for their children and replaced the labor of their children engaged on-farm by hired labour. It also decreased the number of drop out schooling. Surface irrigation systems are labour-intensive operation and it requires the engagement of more labour than rain-fed agriculture keeping other things unchanged. Therefore, irrigation can increase employment opportunities and rural households' income. This, in turn, enables them to get access to food by improving the purchasing power of individuals. It is found that the existence of irrigation can increase income by creating more employment since it is labour-intensive.

According to (Awulachew, 2010). Reduced degradation of natural resources, increased exports, increased job opportunities, and promotion of a dynamic economy with rural entrepreneurship. Despite significant efforts by the government of Ethiopia and other stakeholders, improving agricultural water management is hampered by constraints in policy, institutions, technologies capacity, infrastructure, and markets. Addressing these constraints is vital to achieving sustainable growth and accelerated development of the sector in Ethiopia.

2.1.8 Challenges and Opportunities of Irrigation Development in Ethiopia

Many challenges face irrigation development in Ethiopia. Some of these challenges are more or less related to technical constraints and knowledge gaps. In this case, the challenges indicated here are typical for small-scale irrigation. Gebre Medhin and Asfaw (2015), identified the challenges for Ethiopian irrigation development as.

(1) inadequate awareness of irrigation water management as in irrigation scheduling techniques, water-saving irrigation technologies, water measurement techniques, operation and maintenance of irrigation facilities, (2) inadequate knowledge on improved and diversified irrigation agronomic practices, (3) shortage of basic technical knowledge on irrigation pumps, drip irrigation system, sprinkler irrigations, surface and spate irrigation methods (4) scheme based approach rather than area/catchments based approach for the development of SSI schemes, (5) inadequate baseline data and information on the development of water resources, (6) lack of experience in design, construction and supervision of quality irrigation projects, (7) low productivity of existing irrigation schemes, (8) inadequate community involvement and consultation in scheme planning, construction and implementation of irrigation development, (9) poor economic background of users for irrigation infrastructure development, to access irrigation technologies and agricultural inputs, where the price increment is not affordable to farmers.

2.1. 9 Irrigation Potential and Participation Situation in Ethiopia

Modern irrigation was started at the Awash River basin with bilateral cooperation of Ethiopia and Dutch company, during the 1950s for the productions of commercial crops such as sugar cane and cotton. The recent source indicates that the total area of irrigated land in Ethiopia increased from 885,000 ha to 2.4 million ha in from 2011 to 2015 with a plan of increasing irrigated land to 4 million by 2020 (ATA, 2016), including the 658,340 ha of land developed with high and medium irrigation schemes. But there is a plan to expand the high and medium schemes to about 954,000 hectares by the end of the GTP-II (2019/20). Evidence also shows that, in Ethiopia, farm size per household is 0.5 ha, and the irrigated land per household ranges from 0.25 - 0.5 ha on average (MoA, 2011).

According to Temesgen, (2017). Ethiopia is a rich country in water resource and most of the time it is termed as a water tower of East Africa because of its abundant water resource availability. It has a huge potential of water resource which accounts for 122 billion meters cube annual surface run-off and 2.9 billion meter cube groundwater, though it is characterized by uneven spatial and temporal distributions. But Ethiopia is using very little of its abundant water resource potential for irrigated agriculture (ATA, 2016). Even though there is no similar evidence about the potential it has from different sources, it has a high potential. The estimated total irrigable land potential in

Ethiopia is 5.3 million hectare assuming the use of existing technologies, including 1.6 million hectare through rainwater harvesting and groundwater (Awulachew, 2010). This indicates that there are potential opportunities to vastly increase the area of irrigated land. This high potential, if it is successfully operated, irrigation in Ethiopia could play a significant role in the agricultural transformation of the country, contributing up to ETB 140 billion to the economy and potentially moving up to 6 million.

2.1.10 Irrigation Institutions, Policy, and Strategies of Ethiopia

Ministry of water resource (M o WR) is charged with aspects of water sector policy, planning, water resources regulation, development and use, and implementation of medium and large-scale irrigation. It also has the responsibility of building the capacity of regions regarding water resource development, and preparation of plans for the proper utilization of water resources. It coordinates projects that involve more than one region, or those that involve international procurement. The Mo WR will render the implementation of the project by establishing a project coordination office .Under the economic policy of the government, the private sector can play a pivotal role in the development of irrigated agriculture. International and local None Governmental Organizations also play a significant role in the study, design, and development of small-scale irrigation schemes in different regions. According to the Ethiopian water resources management policy overall objective of irrigation policy is to develop huge irrigated agriculture potential for the production of food crops and raw materials needed for agro-industries. The irrigation policy encourages irrigation activities to be implemented on an efficient and sustainable basis and without degrading the fertility of the production fields and water resources base.

The specific objectives are:-

- Development and enhancement of small scale irrigated agriculture and grazing lands for food self-sufficiency at the household level.
- Development and enhancement of small-, medium-and large - scale irrigated agriculture for food security and food self – sufficiency at the national level including export earnings and to satisfy local agro-industrial demands.
- Promotion of irrigation study, planning, and implementation on economically viable, socially equitable, technically efficient, environmentally sound basis as well as the development of sustainable, productive, and affordable irrigation farms.

- Promotion of water use efficiency, control of wastage, protection of irrigation structures, and appropriate drainage systems.
- Ensuring that small ,medium and large-scale irrigation potential projects are studied and designed to a stage ready for immediate implementation by private and/or the government at any time. A report by Nile Basin Development Challenge -NBDC (2011). Stated that in Ethiopia several important policies have been developed and adopted, however, five major challenges are quite often mentioned concerning policy implementation. Those are:
- In many instances, policy implementation guidelines, laws and regulations are lacking. There is a general lack of policy implementation capacity at all levels.
- There is a general lack of proper policy implementation, monitoring, and evaluation.

Policies are made without adequate assessment and drawing lessons of existing/old policies (strategies).Policy coordination and integration (across sectors) is a challenge. Some main problems are witnessed in policy formulation and analysis, these problems and shortcomings are relate to the small amount of consideration given to taking pieces of evidence from grassroots and (through development performance evaluations).

General lack of an adequate and up-to-date database for policy formulation.

- Lack of adequate analytical skills, models, and knowledge.
- The absence of informed debate among the various stakeholders to feed into policy formulation and planning.
- Weak networking between the different stakeholders in policy formulation and implementation.

According to the MO, the WR irrigation development strategy is one of the sub-sectors dealt in the water sector strategy. The principal objective of the irrigation development strategy is to exploit the agricultural production potential of the country to achieve food self-sufficiency at the national level, including export earnings, and to satisfy the raw material demand of local industries, but without degrading the fertility and productivity of country's land and water resources base.

More specific objectives of the strategy are:

- Expand irrigated agriculture & Improve irrigation water-use efficiency and thus the agricultural production efficiency
- Develop irrigation systems that are technically and financially sustainable (Tigist ,2016).

2.3. Empirical Literature Review

Hussein and Hanjira (2004). Confirmed a strong direct and indirect linkage between irrigation and poverty, direct linkages operate through localized and household level effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production, increased production makes food available and affordable for the poor.

IFAD, (2006). Small scale irrigation interventions for system productivity and natural resource management in Ethiopian highlands to assess the benefits and associated environmental effects of SSI investments of the international fund for agricultural development (IFad). Data from the sites indicated that 50 % of the respondents had improved food security and higher income, while 26% of the respondents did not see any change in their livelihoods. Crop yield under irrigation was by 35% to 200% higher than under rainfed conditions, with much higher benefit obtained from high potential areas and in farms where external inputs (fertilizer, improved seeds, and pesticides) are accessible. The positive effect was more visible with horticultural crops. There has been also a shift towards improved varieties with access to irrigation, farmers replaced early maturing but low yielding varieties with high yielding varieties, crop diversification increased significantly, in some sites from 3 to about 15 species although this decision-making process did not favor legumes.

Kinfe Et Al. (2011). Effect of small scale irrigation on the income of rural farm households academic journals, the case of Laelay Maichew District, Central Tigray, Ethiopia the study findings highlights that small scale irrigation for food security enhancement and sustainable environment is technologically and socioeconomically demanding intervention currently being undertaken in rural Ethiopia. However, the high yields obtained in irrigation and other benefits such as increased incomes, employment creation, and food security are indications that irrigation can bring sustainable agriculture and economic development without affecting the environment negatively if properly planned.

***Gadissa,(2016*)**. The contribution of small scale irrigation to household farm income and food security the case of lake Tinike irrigation scheme indicated that households participating in irrigation

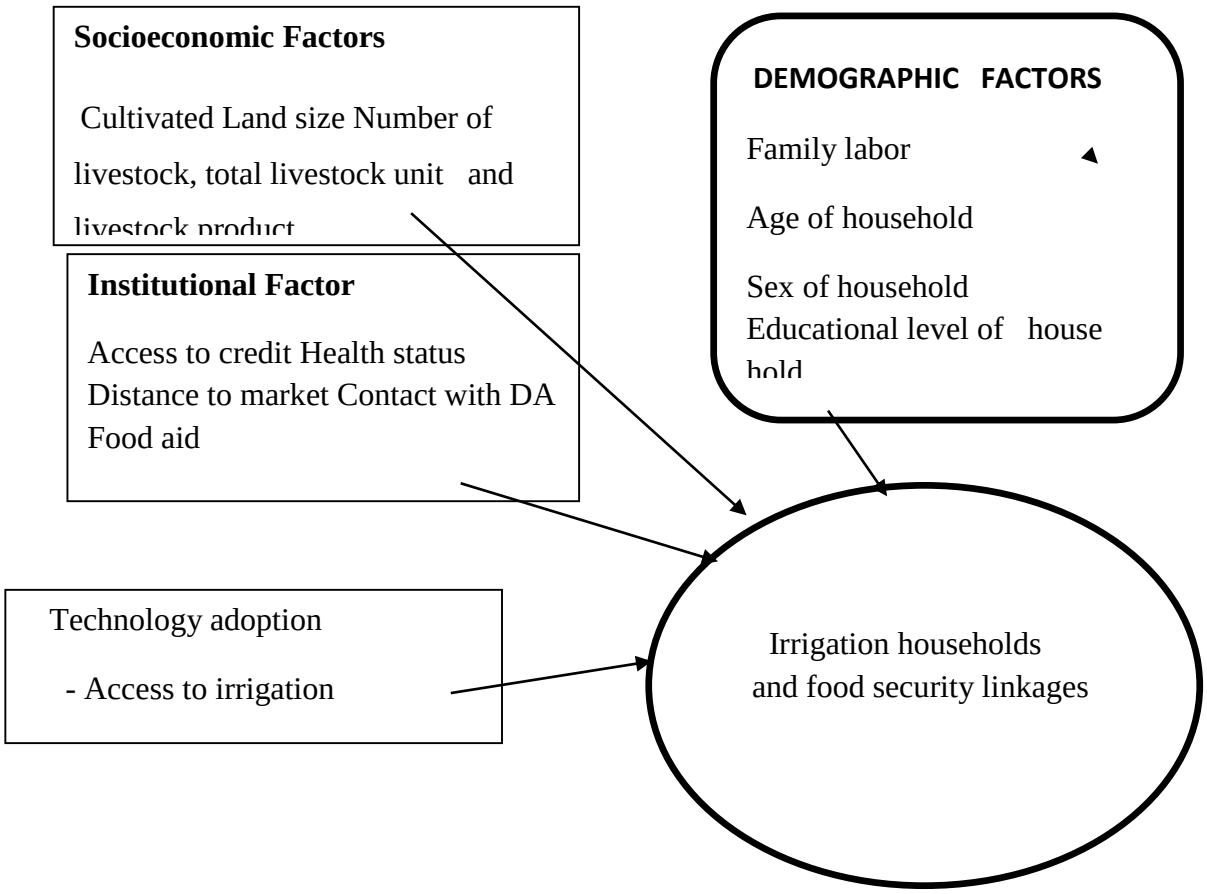
are better off in food security status and farm income compared to those households who do not participate in irrigation practice.

Dereje, et al, (2016). Agriculture article assessment of the impact of small-scale irrigation on household livelihood improvement at *Gubalafto* district, north *Wollo*, Ethiopia. the application of SSI improved the annual income of irrigator households from 1978.12 to 10,099 Ethiopian Birr (ETB) (1 Usd « 20 ETB) before and after using irrigation with a standard deviation of 1534.32 compared to non-irrigators who have annual average income of 3146.75 ETB with a standard deviation of 1838, respectively. It proved that 32.1% of irrigators increased their frequency of production due to irrigation.

Conceptual Framework of Household Food Security

The analytical framework shows that the linkage between household food security and variables assumed affects household food security in the study area. According to their nature, these variables are categorized under four categories. Demographic characteristics include age, sex, educational level of the household head, family labor, year of irrigation, Institutional factors category includes access to credit, access to information, market distance, and contact with development agent and food aid, socio-economic factor involves farm size, livestock size, and technology adoption such as access to irrigation link to food access, food availability and utilization of food that is three dimensions of food security.

Figure 1: Conceptual Framework of irrigation households' and food security linkages



Source Adapted from Tizita (2017).with some modifications.

CHAPTER THREE

3. RESEARCH METHODS

3.1. Description of the Study Area

Ethiopia is situated in East Africa and lies between 3°30´ and 14°50´ north latitudes and 32°42´ and 48°12´ east longitudes. It has a surface area of about 1.127 million km², of which 1,119,683 km² is and 7,444 km² is water. The country has a land boundary length of 5,311km. Ethiopia has special features because of its topography, geology, and climate Awulachew *et al.* 2010). As cited by Getaneh (2011).

Ethiopia is a landlocked country consisting of nine independent regions and two city councils divided along ethnic lines. It occupies an area of 1.14 million square kilometers. The country shares its international borders with five African countries: Eritrea in the north, Djibouti, and Somalia in the east, Kenya in the south and Sudan in the west. Ethiopia is one of the poorest countries in the world with a population of 83 million in 2008 being second-most populous.

Amhara region is located in the northern part of Ethiopia with a total area of 170,752 square kilometers (km2). The region has a common boundary with Tigray in the north, Oromiya in the south, the Afar region in the east, and the country Sudan in the west. It extends from 8º45'n to 13º 30'n latitude and from 36º e to 40º 45' e longitude. The majority of the people living in the highlands are traditionally subsistence grain farmers with surplus production farmers constituting quite some portion of the high land. the fluvial patterns created by the high mountains and the mountains plateau with spectacular configuration ranging from 2000 up to 4620 meters above sea level feature the dominant topographic glamour of the country.

The north and central massive of the semen mountains and high land plateau of Gojjam, Gondar, and north Shoa together with eastern highlands of Wollo is the main feature of the northwestern high lands of the country which is also part of the region.

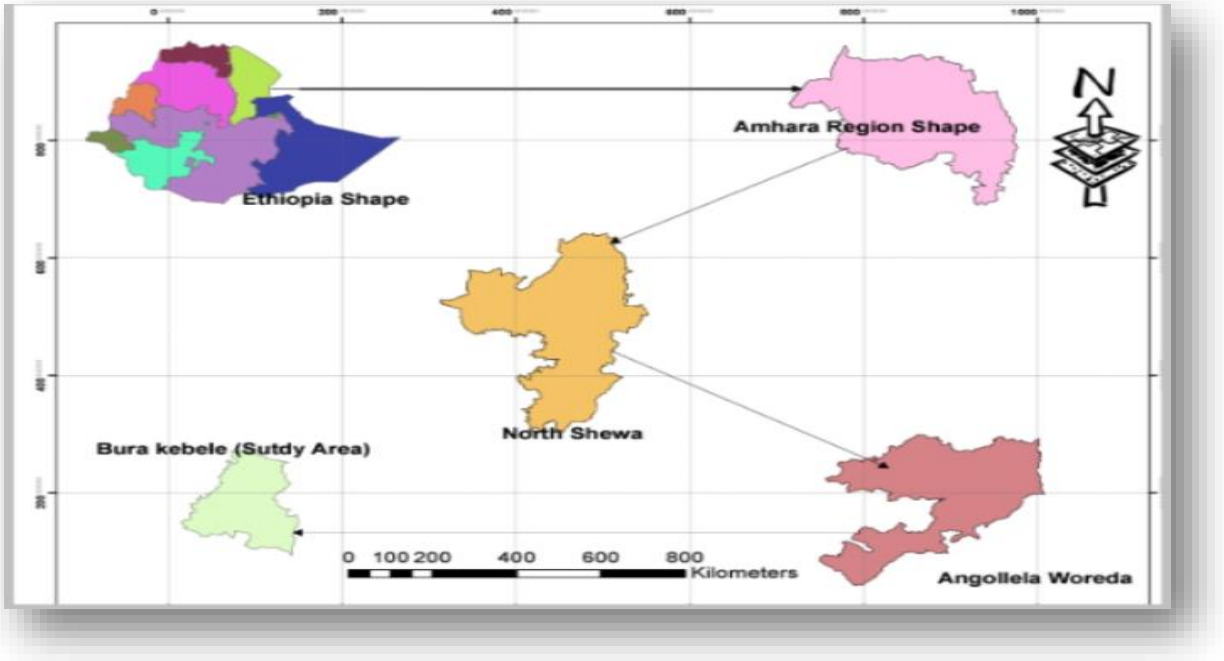


Figure 2 Location map of Angolela district, Amhara, Ethiopia

3.1.1. Angolela Tera Woreda

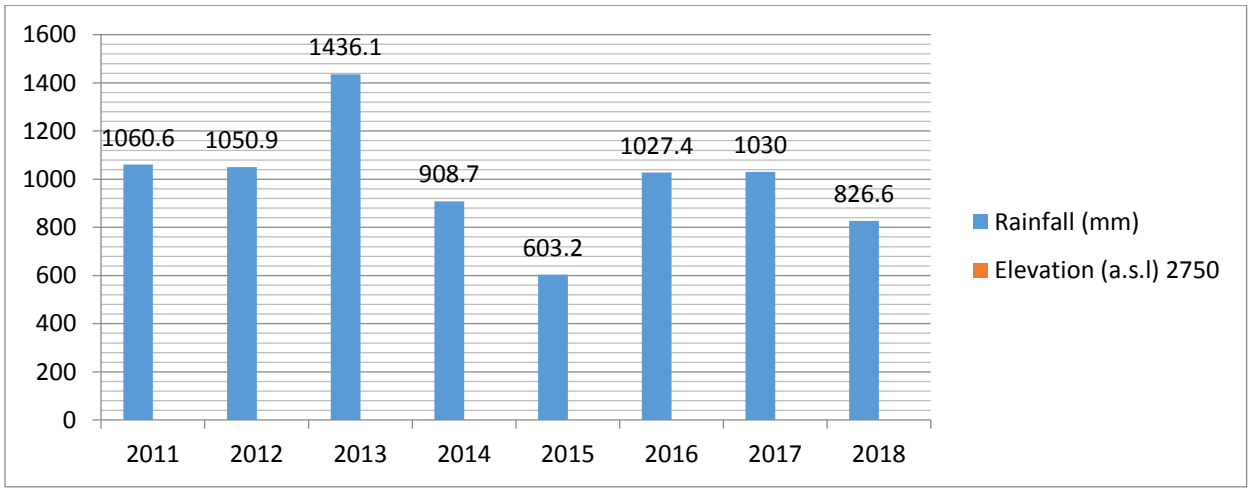
Angolela Tera *Woreda* is located in the north Shoa zone of the Amhara national regional state. Woreda capital, (Chacha, is located 110 km north-east of Addis Ababa (Addis- Dessie highway). It is 20 km away from the zone capital, Debre Birhan. The *woreda* shares boarders with Berehet, Hagere Mariam, and Kessem *woreda* in the south-west, Oromiya region in the west, Baso-Worana *Woreda* in the north, Asagirt *woreda* in the north-east and Ankober *Woreda* in the east.

The total population of the *woreda* is estimated at 90,907 of which about 49. 2% are female and 50 .8% are male. the total number of households in the *woreda* is 21,386. the majority of the inhabitants of the *woreda* are, Amhara ethnic group comprises 88% while Oromo ethnic group constitutes 12% but in Bura 80% Amhara ethnic groups the rest 20%of them, Oromo ethnic groups. The total number of adult males and adult females are 13859 and 13935 respectively, the total number of boys and girls constitute 32350 and 30763 (CSA, predict census result 2019).

The main source of livelihood for the population is mixed agriculture. About 98% of the population in the *Woreda* depends on agriculture for their livelihood. Most of the people depend on the main

rainy season for their annual crop production. Perennial and seasonal springs are found in most of the rural *kebele* administrations and they are mostly used for traditional irrigation practices, animal and human consumptions *(*Woreda Moa, 2019).

The total area of the *district* is 98,900 hectares of which 1602 ha is irrigable and 1576 ha is already irrigated. The topography is dominated by flat land, the land use pattern of the district is such that 51.1.9% is cultivated land, 36 .89% grazing land, 2.89% forest-covered, 5.79% shrubs and bush, and the remaining 2.33% is covered with water bodies. The average landholding size of the community in the *woreda* is estimated at 1.78 hectors per household. The major farming practices include crop rotation, intercropping and fallowing, the fallowing practice is intended for regaining of soil fertility to increase crop yield, and the major types of crops grown include: barley, wheat, field bean, lentil, chickpea, field pea haricot-bean, teff, & linseed. Moreover, horticultural crops such as carrot, cabbage, Swiss chard, tomato, onion, garlic, pepper, and potato. There are also 7,332 horses, 12065, donkeys, and 365 mules *(Woreda, Moa, 2019*). The area is among those *woreda* with the highest livestock population in the zone, in the *woreda,* there is an estimated number of 37,185 cows, 25,467 oxen, 10,226 calves, 120,132 sheep, 14,876 goats, and 57,452 poultries.



Source National Metrology 2019 Addis Ababa.

Figure 3: Rain Fall Data From (2011-2018) Eight Years Data Debre Berhan Metrology Station

The annual rainfall is erratic and varies widely. Accordingly, the mean annual rainfall ranges from 2011-2018 1436.1 to 603.2 mm. Data collected from the metrology center in Debre Berhan, which is located 20 km north of the study sites. The rainfall is seasonal, has poor distribution across areas, and is variable from year to year. It is bimodal; there is a short rainy season, locally known as "Belg", which occurs between February and April, and a long rainy season, the "kiremit", which occurs between June and September the highest intensity of rainfall is recorded in July. In most cases, the highland areas/ Dega zone are mainly dependent on Belg rain, whereas the Woinadega and Kolla areas are meher rain-dependent for crop production. Irrigation Potential for the Major International River Basins in Ethiopia

1. Irrigation intensity: - It assesses the rate of use of land equipped for irrigation. It is calculated as the total irrigated land per the total irrigable land in a particular area.

River	Mean Annual water flows (BM3 river	Catchment Area (km2)	Irrigation Potential (ha)	Irrigated Land in 2010 (ha	Irrigation intensity1 (%)
Tekezze	7.6	83476	83368	33760	40.49
Abbay	52.6	198891	815581	65404	8.02
Baro-Akobo	23.6	76203	1019523	18571	1.82
Omo-Ghibe	17.9	79000	67928	56057	82.52
Rift Valley	0.12	52739	139300	35846	25.73
Mereb	0.26	54600	67560	910	1.35
Afar Denakil	0.86	63853	158776	627	0.39
Awash	4.6	110439	134121	120375	89.75
Wabi-Shebelle	4.6	202220	237905	31701	13.32

Genale dawa	5.8	172133	1074720	4910	0.46

Table 1: Irrigation Potential for the Major International River Basins in Ethiopia

3.1.2 Agriculture and Livestock Production

Agriculture is the mainstay of the people in the study area and the district is a high potential for crop and livestock production.

3.1.3 Livestock Income of the Respondents

Next to crop production, livestock is the most important productive asset. It plays a role in

religious and cultural ceremonies, is a source of power for ploughing, and serves as source of

Prestige In line with this particular reference, livestock is also considered a saved asset used

during the periods of food shortage .According to the data collected from KI and FGD, because water is accessible from the irrigation canals, irrigator farmers have high animal feed potential both from irrigated and rain-based cropping and animals do not need to be sold to get food Therefore, each irrigator household has high livestock numbers with relatively good quality and they have the potential for a higher income from the sector. There are also households who practice intensive farming (dairy and fattening), However, unlike irrigators, non-irrigators have insufficient animal feed resources. Milk supply center in their village daily receive 5-8 liters of milk

to the center and also milk product butter and cheese selling in the nearest market

The FGD further indicated that due to absence of enough food, and because what is there is only from rain-fed cropping, the livestock of the non-irrigators' are necessarily sold to get food. Therefore, each non-irrigator household had a small livestock population with poor quality.

After the intervention of the food security strategies the food security households' improved there status asset building and get sufficient amount of food.by livestock product and by product.

(Data Source From 2019)

3.1.4 Crop Production

The common crops produced by farm households in the area include barley, beans, and lentils Farmers also grow vegetables such as garlic potato, carrot, and lettuce by using small irrigations, in the area,

Type of crop	**Area in ha**	**Production in quintals**	**Productivity in quin/ha**
Barley	170	1700	10
Holkare	5	75	15
Garlic	47	4230	90
Carrot	33	1320	40
Beans	110	2200	20
Peas	2	30	15
Lentils	1	5	5
Vetch	1	5	5
Fenugreek	1	3	3
Lettuce	4	100	400
Potato	2	50	100

(Source 2019 Survey Data).

Table 2 Type of Crops in Bura Kebele small scale irrigation

3.1.5 Food Consumption Score

Food consumption score :(FCS) is calculated from the types of foods and the frequencies with which they are consumed during a seven-day period .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 data collected both house hold male and his wife.

Food Items, Food Groups and Weights for Calculation of the FCS

1 Cereals: barley,(black barley for injera),white barley for porriage ,besso,qita(terosho, (local name).

2 Wheat for (Bread, nifro ,qollo,)

3 Roots and Tubers: potato, carrot,

4 Pulses/Beans/ , shero, kollo

5 Milk/ Milk Products milk , cheese, butter. Yoghurt

6 Animal Proteins: Meat, Eggs Meat Vegetables (including green, leafy vegetables) Cabbage, tomato and habesha gomen

7. Nonfood items. Sugar/ salt,

8 Fruits, fruit Oil and Fats Oil Source: World Food Program (2007).

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

FCS=$a\times f$(staple)+β×f(pulse)+γ×f(vegetables)+γ×f(fruit)+δ×f(animal and (animal products)+$\varepsilon\times f$(sugar)+$\delta\times f$(dairy)+$\varepsilon\times f$(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.(Tizita,2017).

3.2 Data Source and Collection Method

The selection of the Angolela Tera district for this research was for the following reasons. The reason that interested me to undertake this research was my previous experience in the area; Because I worked in the North Shoa zone as an expert and coordinator for the zonal Ministry of Agriculture for twenty years and as a food security coordinator and woreda irrigation expert in Angolela Tera district for five years, during the first phase of productive safety net started. Therefore, from my experience, I was able to see that the district is one of the food-insecure areas. This made me interested to go deeper and investigate the relation of small scale irrigation to household food security. Another motive was that the area has good potential in irrigation, due to its unique topographic and agro-ecological features although technical skills and innovative irrigation technology are absent. As a result a significant proportion of the population of the district has experienced hunger and malnutrition for the past many years. Furthermore, the unique topographic and agro ecological features of the area have also contributed to the initiation of this research.

The data required for this study were collected from sample respondents using a semi-structured questionnaire; the enumerators for the data collection were selected based on their educational background and their ability of the local language. 3days training was given to the enumerators about the method of data collection and the contents of the questionnaire. Data collection proper was started after the pretest was conducted and modifications were made based on the feedback from the pretest three enumerators in sampled kebeles were employed to survey under the close supervision of the researcher, the enumerators were development agents in one kebele. Development agents were chosen as enumerators due to their knowledge and acceptance among the community that helped the researcher get the questionnaire filled properly. Appropriate training, including field practice, were given to the enumerators to develop their understanding regarding the objectives of the study, the content of the questionnaire, how to approach the respondents, and conduct the interview. Some adjustments have been made to the final version of the questionnaire and proper data collection was started with the day to day supervision of the researcher. Focus group discussion, key informant interviews, and direct personal observation were also used to collect qualitative primary data by the researcher. Personal observation of the site helped me to understand the overall process of irrigation development and crosscheck data gathered through the household survey and key informant interview. In addition to primary data,

secondary data that could supplement the primary data were collected from published and unpublished documents, district and zonal offices of irrigation development (Oid), district and zonal offices of agricultural and rural development (Oard). Woreda cooperative association offices, woreda irrigation experts and team leader, woreda input supply team leader in agriculture offices are some of the offices from which secondary data were obtained .Regional central statistic authority and also national methodology agency a source of secondary data too.

Focus Group Discussion

Regarding the focus group discussion, village elders, who were believed to be knowledgeable about the pre–irrigation and post-irrigation circumstances of the village including the socioeconomic conditions of the community, model farmers‘ and the youth were identified and included in the discussion. Separate sessions of discussion were arranged for male and female participants so that the groups were able to speak out their feelings freely and more comfortably. Two focus group discussions by using checklist at study area were conducted and each focus group comprised 12-13 individuals the total 25 . This enabled us to get data about the contribution of irrigation to farm household income and to obtain opinions, attitudes, and views from the group discussion participants and it helped to clarify and crosscheck ideas and experiences that have been gathered through a household survey.

Key Informant Interview

The primary data collected from sample farmers need to be further enriched by additional information gathered through key informants. Thus, an intensive interview has been conducted with key informants, thus, four experts from three different departments, such as irrigation, extension coordinators and productive safety net program expert, two development agents (Da) from sample kebele, three committee member of irrigation water user's association from each villages was included as a key informant interview. The total key informant five (10).

3.2.1 SAMPLING TECHNIQUES

In this study the smallest unit was household, purposive sampling was used to select woreda as well as kebele. the researcher put criteria to select those one kebeles including low-income community, availability of irrigation schemes and the status of food security, the study had predetermined 150 samples it used systematic random sampling in which every k.th subject to the sampling interval and

every $2th$(k=2) households the value of k was determined by dividing total households in the sample size. However, due to intolerance, missing elements with the ten households' questioner the researcher decided to work on 140 farming Households in addition to focal group discussions and key informants. Some adjustments have been made to the final version of the questionnaire and proper data collection was started with the day to day supervision of the researcher. Focus group discussion, key informant interview, and direct personal observation were also used to collect qualitative primary data, my observation of the site helped me to understand the overall process of irrigation development and crosscheck data gathered through the household survey and key informant interview. In addition to primary data, secondary data could supplement. The primary data were collected from published and unpublished documents, district and zonal offices of irrigation development (oid), district and zonal offices of agricultural and rural development (oard), woreda cooperative association offices, woreda irrigation experts and team leader, woreda input supply team leader in agriculture offices are some of the offices from which secondary data were obtained regional central statistic authority and also national methodology agency.

3.2.2 DETERMINATION of SAMPLE SIZE

Yamane (1967): Provides A Simplified Formula To Calculate Sample Sizes.

This formula was used to calculate the sample sizes .95% confidence level and p =0.5 are assumed for equation

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision when this formula is applied to the above sample, we get equation 6. n=300house holds/1+300(.05) ²= 150 households select to collect data, but real able data have only 140 households responded clearly. Secondary data was collected from relevant sources such as books, journals, related documents, and from the offices of the zonal agriculture, irrigation development offices, and other relevant institutions, such as central statics, census, production of irrigation, and other rainfall data in national metrology agency.

3.2.3 DESCRIPTIVE STATISTICS RESULTS

The descriptive statistics were run to observe the distribution of the independent variables. the socio-economic and institutional characteristics of the respondents such as availability of family labor

force, age, sex, level of education, landholding, access to information, livestock holding, total income, access to credit, perception about soil fertility, access to extension service, distance from home to the water source, distance from the nearest market. The users of small-scale irrigation were analyzed, the total sample respondents interviewed 140 were found to be users of small-scale irrigation households', these were 100 percent of the total sample households were irrigation beneficiaries.

Similarly, a correlation matrix to test the significant associations between small scale irrigation and household food security both agricultural production and income. The sample households' food security status would determine using correlation analysis. Such as family size, age of household heads, frequency of extension service, and access for information, cultivated area, amounts of chemical fertilizer use, and participation in irrigation farming were an example of variables which affect the food security status of the farm households in the study area. The data generated through household questionnaire was analyzed by employing the statistical package for social sciences (SPSS version 20).

Definition of Dependent and Independent Variables

The dependent variable of this study is access of the small-scale irrigation and food security scheme in the target district. There are quite a variety of factors which can affect house hold food security both positively and negatively, it is very difficult to enumerate and discuss all the factors that affect house hold food security. However for the research at hand, some of the major factors affecting House hold food security status are considered, based on the economic theory and results of previous empirical studies, each variable is defined with its hypothesis as indicated below.

1. **Age of Household Head (AGEHH**): 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 and other related studies stated that young head of households were stronger and were expected to cultivate larger-size farm than old heads. Hence, the expected effect of age on household food security could be positive or negative.

2 Family Size (FAMSHH): It Is an independent variable, which represents a group of people living in the same house, jointly sharing food and comprising one family with a common head, this variable was measured as a continuous variable by taking the total

number of family members in the household, this variable is hypothesized to affect food security and production level of the household positively, this is because as labor is the main input in crop production, a farmer that has large family size could carry out important crop husbandry practices timely.

3 Sex of the Household Head (Sex "Him"): independent variable taking 1 if the household head is male, 0 if the household is female. Male-headed households are in a better position to pull labor force than the female-headed household., moreover, concerning farming experience males are better than female farmers, sex of the household head has a significant impact on food security status, male-headed households have relatively high labor than female-headed households and male-headed households are economically better off than the female-headed households who face labor shortage .moreover male-headed farmers have more access to information than female household heads, following these arguments, a positive relationship is hypothesized between a male household head and income and food security status.

4 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 produced consumable food grains or/and diversify their cropping and supplement moisture deficiency in agriculture. In doing so, it helps to increase production. It was assumed to have a direct relationship with household food availability. Hence, those household have an access to irrigation was expected to have positive impact on household food security status.

5Technology Adoption: technology adoption refers to the use of farm inputs such as improved seeds, agrochemicals, access to irrigation water, and chemical fertilizer use with improved agronomic practices. Households that report having used some package of technology were considered adopters and those that have not used this package were considered non-adopters. This was measured using the adoption rate. The use of a motorized water pump and treadle pump as part of water lifting technology and other water lifting technologies have increased agricultural production. in this study different irrigation systems using a traditional method, modern irrigation systems like furrow, and using motor pump the major one technology adoption is expected to increase food security through its effect of increasing food availability and income.(Nahusenay et.al, (2015).

6 **Distance from the Nearest Market (Dismkt):** it is measured in kilometer. It refers to the distance between the households' farm and nearest market center, it shows access to the market to buy input and/or to sell output. As the farmer is closer to a market, the higher will be the chance of participating in small-scale irrigation. It is also about securing information at a market place, the farther the market center is the lesser the income from the sale of farm production. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving at the market, and to avoid such incidences the farmer sells his output for cheaper price reducing the income. Therefore, distance from the market is hypothesized to influence positively the farmers' decision to participate in small-scale irrigation and income. The distance from the nearest market for each household in each sample kebeles was measured from the distance from the farmers 'land to Chacha which is the Woreda capital and it is the nearest market for the sampled villages and *Kebeles.*

7 Education of Household Head (EDUHH H): The educational level of the household head is a continuous variable and expected to be related positively with food security and income level. Since education is important in measuring the income-earning potential of a household. Educated farmers can acquire and process information easily which may lead to more adoption of technologies. A study by Abebaw (2003). Indicated that education of household head has a positive and significant effect on household food security**,** similarly, it refers to the number of years of formal schooling a household head had completed, formal education enhances farmers' ability to perceive, interpret, and respond to new events in the context of risk (in most studies, educational status of farmers is positively related to the adoption of new technologies by farmers. in this study, it is hypothesized that the educational level is positively related to the utilization of irrigation\ water and subsequently with households' food security status.

8 **Access to Information (Acin fo):** it is a dummy variable, which takes 1 if the farm household has access to information and 0 otherwise, access to information refers to the ownership of radio, mobile, that the farmers have the advantage of getting information about new technology. The farm household that owns either radio or mobile or both are expected to have a high probability to participate in small-scale irrigation, due to this the income will be high, it is, therefore, hypothesized that it affects participation and income positively.

9 **Access to Credit Facility (Accredit):** it is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise, access to credit is an important source of investment, those households who have access to credit have a better possibility of getting farm inputs, therefore, it is hypothesized that access to credit determines farmers' decision to participate in small scale irrigation and income positively, credit helps farmers purchase inputs such as seeds, fertilizers, and chemicals.

10 **Total Livestock Holding (Livestock):** this refers to the total number of livestock measured in tropical livestock units (Tlu). A household livestock size in Tlu is calculated by multiplying the number of each type of animal by an appropriate conversion factor and then summing, livestock is an important source of income, food, and draught power for crop cultivation in Ethiopian agriculture. More livestock holding is expected to increase the probability of participation in small scale irrigation. Livestock may also serve as a proxy for oxen ownership, which is important for farm operations. therefore, in this study it is hypothesized that higher Tlu will have a positive influence on the participation in small scale irrigation and level of income particularly the owner of more oxen lead to an ability to cultivate more land on time, thereby achieving crop yields and earning a higher income, increased agricultural production. TLU (Tropical Livestock Unit) is International Animal Resources Measurement Unit Where In 1 TLU (Equals 1 Camel, 0.7 Cows, 0.8 Oxen, 0.1 Sheep/Goat, 0.5 Donkeys, 0.45 Heifer/Bull, 0.7 Mule/ Horse, 0.2 Bee Colonies Or 0.01 Chickens (Randela et Al. 2000).

11 **Soil Fertility Status (Soil Fert):** it is a dummy variable which takes value 1 if the land is fertile and 0 infertile, where soil fertility is determined based on the response of the surveyed households, Fertility of land has a direct relationship with productivity, if the farmland is fertile the household can produce more and if the land is infertile less will be produced affecting the household income level, thus, it is expected that households with fertile land have more income.

12 **Labor** is a dummy variable and one of the major inputs used in small-scale irrigation schemes, trained and experienced labor is an essential production factor. Family labor is the major source of labor for both irrigation schemes except during peak production period, i.e. transplanting, weeding and harvesting when farmers hire additional labor, the wage rate in the area ranges from 120-150 birr per day depending on the production period, during peak periods

wage rate increases due to shortage of labor. Both male and female laborers are involved in production activities. Male labors are involved in all production activities whereas females are mostly involved in planting, weeding, and harvesting time.

13 **Frequency of Extension Contact**(Frqextserv*):* this refers to the number of contacts per year that the respondent made with extension agents and it is a continuous variable, the effort to disseminate new agricultural technologies is within the field of communication between the change agent (extension agent) and the farmers at the grass-root, here, the frequency of contact between the extension agent and the farmers is a potent force which accelerates the effective dissemination of adequate agricultural information to the farmers, in this study, higher frequency of agricultural extension contact is hypothesized to positively influence the contribution of small scale irrigation and food security of households.

14 **Size of Cultivated Land (Cult Land):** this refers to the total cultivated land size (both irrigated and rain-fed) of a household measured in a hectare. it is a continuous variable, as the cultivated land size increases provided other associated areas, farmers who own farmland are richer in relative terms than those who do not. as discussed in the focus group discussion the size of farmland owned per household has been shrinking for so long due to the ever-increasing human population and the severe problem of land degradation in the farmland which has transformed most of the farmland is not possible as the potential is limited by the strong nature of local topography and land tenure system.

15 On-Farm Income (Onfinco): it is measured by the amount of birr obtained from the sale of farm products, the farm income refers to the total annual cash earnings of the family from the sale of crops, livestock and livestock products, this is believed to be the main source of capital for purchasing agricultural inputs, thus those households with a relatively higher level of farm income are likely to purchase improved seeds or other essential agricultural inputs, so it is expected to have a positive relationship with overall agricultural product of the households and food security status.

15 **Health Status of the Household Head (HSHH):** To work farming activity, physical wellbeing of the farmer was mandatory. The farmer was able to involve in farming work and

management aspect of the farm if he/she is healthy. So, health status of the household head was influence the food security situation. It was measured in days per year that the household head was sick (out of farming work). Good health status was expected to influence the food security situation of the beneficiaries positively. (Tizita, 2017).

16 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

4. RESULTS and DISCUSSION

This chapter presents the results of the study, it begins with results from preliminary descriptive statistical analysis of socio-demographic characteristics 0f the study sample and other key variables of the study and this is followed by correlation analysis.

4.1. Results of Descriptive Statistics Analysis

This chapter presents the results 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 sampled households by using explanatory variables. The second sub- section focuses on the measuring of food security using household food insecurity access scale in order to determine the food security status of sample households and focus on household dietary diversity and food consumption score of sample households. The third sub section presents the results from correlation matrix analysis that the association of small scale irrigation to the house hold food security that is food availability , food access and utilization. Finally strategies that can promote small scale holder farmers in improving food security status.

4.1.1 Household Food Consumption Score

The data on food consumption of 140 households was collected for this study designed for capturing the variety and frequency of different foods consumed over a 7 day recall period. Below shows results of sample households' food security status using food consumption score for irrigation users' households, by using the food consumption score cut-off, the results showed that irrigation users with acceptable food consumption were 86.4% or 121 respondents while 10.7 % or 15 respondents' irrigation users had medium consumption and 2.9 % or 4 respondents of the irrigator households were with poor food consumption score. According to the food consumption score, households with poor consumption are regarded as food insecure, while households with consumption are categorized as moderately food insecure and the households with acceptable food consumption were categorized as food secure, (Wfp, 2007)

Food consumption score	frequency	Percent
Adequate food consumption (>42)	100	71
Border food consumption 28.5-42	34	24
Poor food consumption(≤28	6	5

Table 3 Food consumption score

4.1.2 Household Dietary Diversity

the results of survey in table 4 show that more than half (86.4%) of irrigation user households had consumed high dietary diversity of greater or equal to 6 food groups. similarly, 10.7% irrigation users, had medium dietary diversity of 4-5 food groups. it is found that only 2.9% of irrigation users had consumed low dietary diversity of less than 3 food groups as

	Frequency	Percent
High(>6 food groups	121	86.4
Medium(4-5 food groups	15	10.7
Low(<3 food groups	4	2.9
Total	140	100.0

Table 4 Household Dietary Diversity

4.2 Food Security Status of Sampled Household

Farmers who have access to irrigate agriculture increased cash income through increased production and productivity of high value crops. The findings of this study indicated that through production of high value crops (vegetables, potato, carrot and garlic, farmers were able to generate a good amount of income, which contributed significantly to households' crop income.

This revealed that irrigated farming has paramount contribution to household crop income in the study area. Besides, irrigated farming has positive contribution to household food security through its contribution in production of subsistent crops and building the capacity of farmers to purchase food crops. The result of this study also shows that income from irrigated vegetable crops is found to influence through its effects on enhancing household subsistent crop production and trade based entitlements.

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

4.2.1 FOOD AVAILABILITY

Physical presence of food in the area is increased due to irrigation facilitating the production to be twice and three times on the same farm land. Vegetables are available for local market for the non-users of irrigation and surrounding people. As the responses of key informants and focus group discussion confirm, the type of vegetable produced in the study area can increase the availability of food items in study area. Irrigation increase fresh vegetable in the area and through market mechanisms increase the availability of food items at household levels and nearby markets. This availability is acquired both in quantity and variety. The SSI scheme users of study area could diversify their production from producing cereals but also enable the production of garlic, potato carrot and lettuce. By planting these crops, as observed and surveyed, they could diversify the source of food items.

4.2.2 FOOD ACCESS

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

The impact of irrigation in income level was gathered from key informants and focus group discussions. According to the results, the ability to acquire adequate amount of food from irrigation users household's increased because they participate in irrigation development through one or a combination of own home production and stocks, or purchases. According to the responses from FGD, irrigation users diversified food crops and livestock product are accessed by irrigation users than non-users. By income from irrigation, the users tend to purchase different food items from market and shops. Food is more accessible to irrigation user households than acquire a sufficient quantity or diversity of food through different mechanisms than non-users. The KI from irrigation users reported that this has brought health benefits, which in turn reduced household expenditure on health care.

4.2.3 FOOD UTILIZATION

Food utilization means ensuring a good nutritional outcome, which is nutrition security. This study did not assess all the dimensions of food utilization, but analyzed the gain from agricultural income increases. As income increases, an increase is expected in the consumption of quality food such as pulses, vegetables, milk and dairy products, which, while adding to calories, contribute significantly to the increase in other nutrients particularly lacking in the diets of the poor. As was observed in the field, the farmers grow potato, garlic and carrot that do help relieving malnutrition. Utilization is considered as ability of household to get more types of food and increased number of meal per day. From the subject in the study area, irrigation users reported that they benefited from improved nutrition, both from direct consumption of the additional crops they grow and from having more income to spend on food. The benefit to children in particular was emphasized the Ki from irrigation users reported that this has brought health benefits, which in turn reduced household expenditure on health care.

4.3 **Availability of Family Labor Force (Farm Labor):**

Labor is one of the most extensively used inputs of agricultural production. The adoption of new technology demands additional labor force for different farming operations.

A household with a large labor force can participate in small-scale irrigation more than a household with a small number of the labor force. Furthermore, Households with large family size will have more number of agricultural labors and hence, will have more agricultural production and more income provided that there is sufficient land to employ the existing labor. In the study area, rural

farm households who faced a labor shortage employ different mechanisms to acquire additional labor required for accomplishing farm activities. Faced labor shortage acquired additional labor through hiring and labor exchange mechanisms respectively. Most of the casual labor employed in irrigation farming was the source from the non-users of irrigation within the kebele or woreda whereas some of the casual labors were from nearby kebele/woredas that are very low in irrigation sources. This proves irrigation utilization intensifies labor and is a paramount strategy to supports the livelihood of the non-users through employment opportunities.

The size of family positive relationship to participate in irrigation products from planting time up to harvesting and transporting the yield to the market in pack animal. Farmers hired daily laborer study report that 103family or 73.6% participated in agronomic practices whereas 26.4% no participate due to their age and education during peak time.

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Size of family members	140	9.00	.00	9.00	776.00	5.5429	1.84419	3.401

Table 5 Size of family members

House hold Education Level (**Educ**). **T**he majority of households are read and write, educational level is positively related to the utilization of irrigation\ water and subsequently with households' food security status. Level of education of the household head Educated people can more easily contribute to the generation of new technologies and more readily utilize those technologies, moreover educated peoples manage their fields properly, and then these activity results have pushed to get good production and productivity of the land.

The study result indicates that the level of education acquired by the head of the household is one of the key determinants of the probability of households' participation in small-scale irrigation; education of the household heads can raise their information acquisition and adjustment abilities

thereby-providing awareness regarding opportunities for productive employment and rational expectation for decision making. Educational attainment by the household head could lead to awareness of the possible advantages of modernizing agriculture employing technological inputs; enable them to read instructions on fertilizer packs and diversification of household.

Education Of Households	Frequency	Percent
Illiterate	2	1.4
Read And Write	81	57.9
1-4 Grade	28	20.0
5-8 Grade	19	13.6
9-12 Grade	10	7.1

Table 6 Education House Hold Head

Application of Inputs: the amount of chemical fertilizer used (CHEMFERT):

This is a continuous independent variable that measures the amount of chemical fertilizer used by sample households. The use of fertilizer improves yield per unit area, and thus food security Thus, it is expected that use of chemical fertilizer will have positive impact on food security. Using artificial fertilizer and natural fertilizer increase the house hold production. The data emphasized beneficiary of irrigation households' artificial fertilizer used in 2018 irrigation production sum of fertilizer used the respondents 1oo respondents used maximum 4 quintals and minimum 0quintals and 26.4% or 40 respondent don't use fertilizer and the other chemicals.

Descriptive Statistics N=140

Independent Variables	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Amount Of Input In Quintal	.00	4.00	175.00	1.2500	1.11642	1.246
Distance To From Home	14	1	15	2.157	1.615	2.608
Market Distance From Irrigated Place	3	1	4	2.35	0.61075	0.373
Total Livestock Unit (Tlu)						

Table 7 **Using Of Agricultural Input, And Other Variables**

Access of Credit

Credit either in the form of cash or kind from different sources is an important institutional service to finance poor farmers for input purchase and ultimately to adopt new technology. However, some farmers have access and utilization to credit while others may not have due to problems related to repayment and down payment to get input from formal sources. The main source of credit in the study area is the microfinance institute (Amhara Credit and Saving Institution (ACSI)) but service cooperatives; also provide credit services to their members. Moreover, nonformal sources were also providing microcredit services to the community. These included: relatives, friends, local moneylenders, local community insurance (Iddir), or rotating savings and credit associations (Equb). The survey result indicated 14.3.% of the sample households utilized credit while 85.7% of the sample households do not have credit.

Response	Frequency	Percent
No	120	85.7
Yes	20	14.3.

Table 8: Access to Credit

Tropical Livestock unit ;(Tlu) is found to have a positive and significant influence on the income of households; livestock holding in tropical livestock unit contributes to total household income directly through the sale of livestock and their products, and indirectly through use as a source of draught power for crop production activities. Moreover livestock, besides its direct role in raising agricultural productivity, helps households stabilize consumption by absorbing income shocks that might arise from crop failures triggered by natural disasters. Oxen are the sole draught power sources and hence lack of oxen besides its negative effect on land productivity signifies a lower economic status of farm households. households with many numbers of livestock particularly oxen, therefore, are likely to raise farm income for they can use other farm inputs more efficiently by bringing additional land into cultivation through either cash rent or sharecropping basis.

Household Health Status

The results in indicated that in the study area out of sampled households 81.5% reported not have health related problem currently while 18.5% of them were suffering from certain sickness Looking into the relationship between health status .

Factor	**yes**	**No**
Lack of research and development	80	20
Lack of reliable markets and information	75	25
Poor farmer organization	70	30
Inadequate input supply system	64	36
Crop pest management practices low	78	22
Unstable institutional set up and inadequate extension services	80	20
Poor soil fertility management		
Appropriate storage facilities	85	15

Source: Research data, 2019

Table 9 Influence the Performance of Small Scale Holder Farmers Bura irrigation scheme.

For this purpose, the researcher asked the respondents to identify those factors according to their perception. Hence, respondents after being interviewed by the researcher had the following views according to their preference.

The results in Table 10 indicated that on average, the majority of respondents were in agreement with the factors that influence the performance of small scale holder farmers at Bura irrigation scheme while the minority of respondents being in disagreement as indicated above.

The factors influencing the performance of small scale holder farmers to poorly attain higher productivity. Furthermore, 80 % of the respondents contended the lack of research and development from the fact of having poorly skilled farmers and extension officers. As irrigation farming is extremely labor-intensive, the presence of skilled farmers and extension officers is vital. However, This has resulted in changes in seasons, irratic nature of rainfall; hence lowering water availability in many parts of the Angolela district.

House hold that participate in irrigation and their experience the data findings compared that an average years of 11.76 with deviation of 9.9 minimum1year and maximum 21 year of the irrigation users.

Descriptive Statistics

	Range	Minimum	Maximum			Std. Deviation	Variance
				Mean	Std. Error		
year of irrigation	20.00	1.00	21.00	11.7571	.43814	5.18419	26.876
N	140						

Table 10 year of irrigation (experience) .

Experienced household's heads are more food secured than non-experienced. if the house hold increase their irrigation experience in one year they adopt new technology and improve status produce market oriented crops and earn their income, (Deribie, 2015).The above data explained there is difference minimum and maximum in range of 20 years.so the focal group discussion and the data stated that the more experience change food security status .

Strategy	Percent	
	Yes	**No**
Promoting new technology acquisition in terms of production methods and inputs	80	20
Increasing access to credit through the promotion of microcredit schemes	85	15
Improving the physical infrastructure and access to marketing the products	80	20
Improving the training of farmers which would result in sustainable and improved performance	85	15
Increasing investment in non-agricultural activities and improving storage facilities	82	18

Table 11: Strategies that Can Promote Small Scale Holder Farmers in Improving house hold food security status

This study was to determine the strategies that can promote small scale holder farmers in improving production. To obtain the information the researcher asked the respondents to highlight some of the mentioned strategies which would promote irrigation activities.

The results in Table 12 showed that, on average, the majority of respondents were in agreement with the strategies that can promote small scale holder farmers towards higher production. This implies that respondents were generally aware that the strategies proposed would promote then and enhance productivity. On the other hand, the minority of respondents were in disagreement as indicated above.

Specifically, the results indicated that 80% of the respondents agreed on improving the physical infrastructure of Bura irrigation scheme to carter for a good number of small scale holder farmers and access to marketing the products to enable farmers to freely sell their products at the reliable market to attain profits. However, 85% of the respondents suggested improving the training of farmers which would result in sustainable and improved performance while 82% of the respondents argued for increasing investment in nonagricultural activities and improving storage facilities which would save farmers in times of little products. On the other hand, the results in

Table 12indicated that 85% of the respondents argued for the increasing access to credit through the promotion of microcredit schemes which would enable farmers to invest more in agricultural activities by utilizing adequate tools and qualified personnel. Likewise, 87% of the respondents reported promoting new technology acquisition in terms of production methods and inputs to enable them to carry on their activities aiming at value addition and supply chain management enhancement.

4.1.2. Irrigation Production of Sample households related to food availability and food access

The agricultural products produced by the sample respondents in 2018 especially irrigation products were 2841 quintals the total income2898325 birr was classified into two categories namely vegetables (garlic, potato, and carrot), and cereal crops (wheat, barley, field beans, peas, lentils, and fenugreek). Based on the data from the respective kebeles the total area covered by small-scale irrigation scheme was in the Bura kebele about 375 ha. From this total amount about 84 ha (22.5%) was covered by vegetables 290.4 ha (77.5%). while the sample respondents produce 201hectars both crop and vegetable productions in the irrigation area

	Minimum	Maximum	Sum	Mean	Std. Deviation
Total Production In Quintal agricultural output (irrigation)	5.00	47.00	2841.00	20.29	10.29
Total Income Of agricultural output (Irrigation)In ETB Birr	2800.00	105600.00	2898325.00	20702.32	16661.20

Table 12: Total Production and Income

4.2. Correlation Matrix Interpretation

Correlation analysis was conducted to identify the association of irrigation and food security house hold variables, with household characteristics and small-scale irrigation related variables. Their are15 variables run in the correlation analysis. The total number of cells in a rectangular correlation matrix is 210 of which 121 cells are presented within the triangle. Due to the symmetrical nature of the correlation matrix. From the total 16 cells, 100% was significantly associated with each other, and out of the total 50% and, 50 % were significantly associated with 0.01 and 0.05 levels.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
age of the respondent (1)	**1**													
Size of family members (2)	**-0.082**	**1**												
gender of the respondent (3)	**-0.138**	**-0.105**	**1**											
market distance from irrigated place(4)	**.200***	**-0.127**	**0.081**	**1**										
Distance to HOME (5)	**-0.165**	**-0.028**	**-0.052**	**-.180***	**1**									
educational status of household (6)	**-0.034**	**0.079**	**0.103**	**0.075**	**-0.062**	**1**								
Acess Of Information? (7)	**.170***	**-0.078**	**-0.09**	**0.06**	**-0.064**	**0.035**	**1**							
access of credit? (8)	**-0.076**	**-0.034**	**-0.048**	**-0.039**	**0.138**	**0.085**	**-0.098**	**1**						
condition of fertility 9	**-0.076**	**0.072**	**0.026**	**-0.098**	**0.061**	**0.056**	**0.088**	**0.053**	**1**					
how doyousolve labor shortage problem?10	**0.013**	**-0.059**	**.216***	**-0.066**	**-0.041**	**-0.035**	**-0.034**	**-0.061**	**-0.044**	**1**				
extention visit 11	**-0.077**	**0.019**	**0.005**	**.200***	**-0.113**	**0.137**	**0.028**	**0.05**	**0.002**	**0.01**				
total land own 12	**.182***	**-0.029**	**-0.14**	**-0.021**	**0.049**	**0.106**	**-0.068**	**0.149**	**0.035**	**-0.06**	**1**			
Food availability	**0.096**	**0.008**	**-0.02**	**-0.061**	**0.016**	**-0.098**	**0.091**	**0.008**	**0.071**	**0.11**	**0.027**	**1**		
Food access in birr	**-0.023**	**0.005**	**.205***	**0.04**	**0.021**	**0.014**	**-0.029**	**0.061**	**0.12**	**0.08**	**-0.01**	**** .367**		**1**

*** Correlation is significant at the 0.05 level (2-tailed**

**** Correlation is significant at the 0.01 level (2-tailed).**

Table 13: Correlation matrix Associated to Demographic and Institution Character

**** Correlation is significant at the 0.01 level (2tailed)**

* **Correlation Is Significant At The 0.05 Level (2-Tailed).**

Contribution of irrigation vegetables 20863.4286 in ETB and income of crop of meher 21636.9857in ETB. The total income contribution of irrigation 43.93% from livestock income whereas the contribution of income of irrigation27.6% and rain fed 28.76% the findings showed that small scale irrigation contribute access of food security and the food security households chance to afford and the enhance purchasing capacity. Irrigation contributes to livelihood improvement through its direct and indirect benefits. The direct benefits of irrigations are; high productivity, lower risk of crop failure, and higher and year-round farm and non-farm Employment, increased income, food security, and poverty reduction. Irrigation enables smallholders to adopt more di-versified cropping patterns, and diversify income base sources. Indirectly irrigation benefits as a potential to become 'nuclei of growth' which are attractive for inward in-vestments in other infrastructure and ser-vices such as banking to facilitate this growth (Hussien and Hanjira, 2004).

The total number of cells in a rectangular correlation matrix is 156, of which 91 cells are presented in the triangle due to the symmetrical nature of the correlation matrix.

The result of the correlation analysis presented in the above table showed that there are 14 variables within the dimension under household characteristics. 8 cells are presented in the triangle. From the total 8 cells 100 % was significantly associated with each other, and out of the total 12.5% and 87.5% were significantly associated with 0.01 and 0.05 levels (two-tailed) respectively. There are significant associations between household characteristics and agriculture production as issues as depicted in the table for example, household members have a positive association with farmland size (r=o.182, p< o.o5)..

Market distance from irrigated place (r= o.200, p=0.05). Market distance irrigation place appositive significant relation to households and also in income due to the irrigated area available to the nearest market. During harvesting especially in the district and the main road is `not far from farm areas. Whereas distance from home to irrigated place (r=-.180,p< 0.05).

Access of information (r=170), $p<0.05$). A positive significant influence on participation in irrigation. This implies that farmers who have access to market information were to have higher irrigation probability than those that do not have market information. Farmers' market information on input and output price would be attracted by the benefit of irrigated farming.

Size of cultivated land; Size of cultivated land has a positive influence on the probability of farm household's food security in the study area. ($r=182$, $p<0.05$). It was significant at 5%. An increase in the size of cultivated land has a positive relationship with the amount of production to be harvested. Therefore, those farmers who cultivated more become in a better position than those who cultivated less. The survey shows that cultivated land has a positive relationship with food security.

Age of the household leader: The variable was used as continues. Age is expected to influence productivity and production as it affects mental and technology handling ability, Furthermore; it has an innovative impression with experience.

There is a positive relationship between household age and productivities up to a certain level beyond which the negative because of mental and physical abilities to carry out activities.

According to the survey result. The educational level of the household head is a continuous variable and expected to be related positively with food security and income level. Since education is important in indicating the income-earning potential of a household. Educated farmers can acquire and process information easily which may lead to more adoption of technologies. According to the study indicated the education of household head has a positive and significant effect on household food security. Similarly, it refers to the number of years of formal schooling a household head had completed. Formal education enhances farmers' ability to perceive, interpret, and respond to new events in the context of risk.

Access of Credit statically significant negative weak correlation with access to credit in irrigation product and income that is (**r=** -0.076, $p<0.01$). it is negative relationship due to many problems that face the farmers to credit and access to irrigation may be explained by the fact that: (1) in Ethiopia, the institutional credits usually give priority to rain-fed agriculture, and (2) the demand for credit among farmers with access to irrigation may be lower irrigated crops and due to problem repayment and down payment to get input from formal sources.

Table 14: Associations of Livestock Assets, Agricultural Product& income,

Correlation	1	2	3	4	5	6
Amount Of Livestock Asset (1)	1.000					
Amount Of Livestock Income (2)	.278**	1.000				
Income From Livestock By-Products? (3)	. 215*	.267**	1.000			
Income Of Crop Of Belg And Meher (4)	-0.072	-0.084	0.11	1.000		
Total Production Irrigation In Quintal (5)	-.166*	-0.036	0.**099**	-0.001	1.000	
Total Income Irrigation (6)	0.028	-0.087	-0.028	-0.142	.367**	1.000

** Correlation Is Significant At The 0.01 Level (2-Tailed).

* Correlation Is Significant At The 0.05 Level (2-Tailed).

The total number of cells in a rectangular correlation matrix is 20. 15 cells are presented within the triangle due to the symmetrical nature of the correlation matrix. The result of the correlation analysis presented in table 15 showed that there are variables within the dimension under, household characteristics. Which 5 cells are presented within the triangle from the total 5 cells 100% was significantly associated with each other. And out of the total 66.7 % and 33.3.5% were significantly associated at 0.01 and 0.05 significantly levels (two farmers who have enough capital are hiring labor for cultivation, transplanting and harvesting. Farmers who do not have the money use their labor and family labor to cultivate their fields by hand and sometimes work to others' farms to get money for the purchase of inputs. Labor input is one of the major inputs used in small-scale irrigation schemes.

Trained and experienced laborers are essential production factors. Family labor is the major source of labor for irrigation schemes. In most cases demand for labor is higher during the peak production period, i.e. transplanting, weeding, and harvesting when farmers hire additional laborers. Both male and female laborers are involved in production activities. Male labors are involved in all production activities whereas females are mostly involved in (planting, weeding, and harvesting)

The number of livestock assets is a positively significant and crucial component of the food security of households (r=.278 p=0.05). And also the income of livestock products and by-products, (r=.215,p<0.5) strongly correlate in Specially oxen are important assets in the production system of farming households. The availability of cows and other animals' one of the food security strategies to create assets and income-generating activities, Major animal type in both schemes are cattle, goat, and sheep. Oxen are used as draught power for plowing and threshing, manure for fuel, and fertilizer. The economic contribution of livestock to households is milk, meat, and hides.

Sheep are also used as a source of cash income in a time of need. Donkeys are widely used to transport agricultural products, fuel wood, water and to transport agricultural products to the markets.

Table 15 Correlation between Household Characteristics and food availability and food access

Correlation	1	2	3	4	5
Activity Family Participate (1)	1.000				
Size of Family Members (2)	0.055*	1.000			
Amount of Input in Quintal (3)	.250**	-0.006	1.000		
Total Production in quintal (4)	-0.088	0.008	0.091	1.000	
TOTAL INCOME (5)	.208*	0.005	-0.026	.367**	1.000

** Correlation Is Significant At The 0.01 Level (2-Tailed).

* Correlation Is Significant At The 0.05 Level (2-Tailed).

The total number of cells in a rectangular correlation matrix is 12. 15 cells are presented within the triangle due to the symmetrical nature of the correlation matrix. The result of the correlation analysis presented in table 12 four showed that there are 3 variables within the dimension under, household characteristics. Which 3 cells are presented within the triangle from the total 3 cells 100 % was significantly associated

with each other And out of the total 66.7 % and 33.3.5% were significantly associated t 0.01 and 0.05 significantly levels (two-tailed) respectively.

Amount of input (r=, 250. p<0.01). The main inputs for distribution are micro-irrigation equipment, seeds, and seedlings, and Fertilizers, positively related to total agriculture production and income. This implies when we increase improved seeds fertilizer and pesticides Productivity and production increase. Total income positively correlated to the amount of input (r=,208, p<0.05).How ever fungicide, Lack of access to improved irrigation technologies the major problem that hinders increase the productivity in the household.

The **focal group discussion** participate in meeting were7 womens from different villages,7 men from different gott,3elderly people ,3 model farmers,3 water user association and 2 development agents total 25 discussed and gave in detail information about the area.

The major problem put in descending order the first problem market linkage second pest and diseases root rot in garlic and aphids in barley and chocolate spot in field beans third problem lack of improved varieties. General opinion on the contribution of irrigation especially in Summer food shortage available in the community but irrigated house hold available food at that time they have covered their consumption by selling their product as well as consume for their own product .

CHAPTER FIVE

5 SUMMARY, CONCLUSIONS and RECOMMENDATIONS

5.1. COCLUSIONS

The history of irrigation Shows that irrigation has played a key role in increasing farmers ' income where it is well managed by lowering the risk of crop failure, irrigation development aims to increase agricultural income and to improve the economic welfare of the rural societies. Irrigation plays a big role in filling the gap in food shortage and to achieve long-term food security. The high and market-oriented yields obtained from irrigation and other benefits such as the creation of employment opportunities, reduced consumption shortfalls, and food security are an indication that irrigation can bring about development and the end of poverty. This study had paid significant emphasis on the contribution of small –scale irrigation to household food security especially irrigation product and agriculture income.

Result of correlation analysis proved the existence of a significant association of house hold food security with and small scale irrigation. Market distance irrigation place $p<0.05$ $r=.200$, access of information $p<0.05$ $r=0.170$ total land own ($p<0.05$, 0.182), agriculture production, whereas access of credit ($p<0.01$, -236), it is negative relationship due to many problems that face the farmers. Total cultivated land owns an a positive association with agriculture production in quintal and cash in ETB (Ethiopian Birr) ($r<0.182$, $p=0.05$) this implies if cultivated land increases agricultural productivity and production increase if other condition fulfilled.

the result of descriptive statics that in the dimension of household characteristics showed the average age of the total sample household was found to be 45 years whereas 24 years and 75 years are minimum and maximum years of age, respectively.

Sex of household characteristics 86.4% of the respondents are male household head and 13.6% of respondents are female household heads.

Angolela Tera one of the most food-insecure areas of the Amhara region. Despite the low productivity and recurrent drought in the study area, it is believed that crop production can be sustainable through the development of small-scale irrigation schemes in areas endowed with

perennial water sources. The result of this study also reveals that in the history of drought in the area, those households who have access to irrigation have survived better than they depend on rain-fed only. The sample households' food security status will determine using correlation analysis with relation to an agricultural product, such as family size, age of household heads, frequency of extension service, and access for information, cultivated area, adoption of new technology and participation in irrigation farming were an example of variables which affect the food security status of the farm households in the study area.

In addition to their normal rain-fed cultivation, irrigating households cultivate crops using small-scale irrigation. The main irrigated crops were carrot, garlic, potato, barley, malt barley, field beans, pea, lentils, vetch, and cabbage These horticultural crops were selected due to good production potential, economic returns and ease of cultivation, the main income sources of rural household in the study area were cropping, and livestock, the variables that significantly predict access to irrigation are household size, size of cultivated land, livestock holding, farmers' perception of soil fertility status, access to credit, nearness to the water source and household size square. The variables that reduce the probability of access to irrigation are large household size, and access to credit. Rain-fed farmers tend to have a large cultivated area. the negative relationship between access to credit and access to irrigation may be explained by the fact that: (1) In Ethiopia, the institutional credits usually give priority to rain-fed agriculture, and (2) the demand for credit among farmers with access to irrigation may be lower for they can satisfy cash needs through sales from their irrigated crops. Household food security, size of cultivated land and household food security are positively related indicating larger farm size improves household food security households with large farm size are found to be food secure.

Access to extension service is also positively related to household food security. Extension workers could play a key role in transferring knowledge to the rural people easily thereby improving production and consumption, capacity building of the existing ones, and training more extension workers might help address the issue .irrigation, input adoption, and production.

However, in the survey result development agents visited by farmers very low, it needs further follow up to the farmers. Irrigated agriculture is basic for input adoption, food security, and economic growth since the district has limited farmland, and unreliable, erratic and untimely rainfall, expansion of irrigation schemes is a feasible option rather than the horizontal expansion of cultivated

farmland, because of this, the government has invested in irrigation schemes. This study explored whether or not the expansion of irrigation farming has enabled farmers in the district to produce market-oriented and use of more of modern farm technologies mechanism.

5.2. Recommendation

Small -scale irrigation is an important development effort to ensure food security if properly implemented, based on the empirical findings reported in this thesis, the following recommendations are forwarded: sustainable food security intervention must not exclude the improvement of production and productivity of agricultural sector through the use of irrigation. This means that development strategies, programmers, or any intervention related to food security through improving agricultural production should not neglect the paramount importance of irrigation. Hence, government and stakeholders should promote the expansion of new irrigation projects on one hand and the existed irrigation development programs should be further strengthened on the other hand.

- **Access to Improved Irrigation Technologies** influence decision of farmers to use SSI water positively and significantly, the government and nongovernment working on irrigation area should assist poor farmers those cannot afford improved technology by subsidizing and supply fertilizers, new variety seed, and motor pumps at a reasonable price to the farmers in the study area.
- **Ensure Fair Price and Timely Reach For Agricultural Inputs**

  Prioritize the development of low price inputs to increase crop productivity, price bargaining power, and profitability of the irrigators is mandatory, even though, the government tried to provide agricultural inputs at a reasonable price, some farmers still are complaining about the price of agricultural inputs, therefore, the government, cooperative organizations, and private organizations should give attention on the supply of these inputs on low price, on time and inadequate amount.
- **Control pest and insect infection** through the provision of chemical herbicides and pesticides at affordable prices.
- **Improving the marketing system**

Production of high-value vegetable crops could be an attractive business in agriculture if it could help farmers to obtain high returns from it. But this achievement is not only the result of a good harvest, but the market is also the most important factor that determines whether to continue or quit the business. The government should not leave farmers' agricultural products to the

interplay of market forces since it is often affected by the fluctuating market price. In this regard, there should be practically applied policies that support farmers to get a reasonable price for their perishable vegetable produce to stay and invest more in the sector. Relevant and timely information has increasing value as the business of irrigation becomes more complex and volatile. Therefore, establishing an effective information system can do much in improving time and situation

Appropriate storage facilities necessary to the Availability of fair price and product market is of paramount importance to the success of irrigated farming. However, the majority of the irrigating farmers in the study area replied during the survey time is that they got low prices during the harvest period. Therefore, the government and other development sectors should give due emphasis to the development of good storage facilities to protect irrigating farmers from unfair prices during the harvest period.**Better Training of Farmers** on improved agronomic practices, crop protection aspects, bookkeeping, irrigation practices, and product marketing is required to increase crop productivity, price bargaining power, and profitability of small-scale irrigation schemes. Angolela agricultural office/nongovernment offices (Ngo) could support the previous recommendation by setting up a farmer's training center. Strengthening or establishing institutions for input supply, output marketing, and credit service to allow rapid progress in the introduction and adoption of productivity-improving technologies and farming practices.

Therefore, conducting further investigation on the problem area by considering additional socio-economic, environmental and institutional factors of the study area could contribute more in raising the performance of small scale irrigation schemes on household food security.

To ensure food security on a sustainable basis and guarantee the continuity of income diversification activities for resilience to shocks .It is essential catalyze a paradigm shift in the attitude of local people to enhance their self-confidence and entrepreneur sprit as well as dietary habit and traditional beliefs of people.

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ADDIS ABABA

COLLEGE OF DEVELOPMENT STUDIES

CENTER OF FOOD SECURITY

Questioner Master Thesis

The questioner is prepared to undertake a study on master thesis on the assesment of small scale irrigation on contribution of household's food security socioeconomic, institutional and demographic factors that support study.The main object of the study to investigate the contribution of small scale irrigation to household income and food security of Angolela Tera Woreda, North *Shoa* zone of Amhara Regional State.For the successful completion of the study your kind response to the items has paramount importance your kindly requested to take time and carefully complete the questionnaire.

The questionnaire you may use " √ " mark to indicate your responses for items with multiple responses. Dear respondents, the result of this study will help different stakeholders and policy makers to make appropriate measures on irrigation development in the future. Your responses are confidential. Therefore, you are kindly requested to provide genuine responses. Thank you for your time and cooperation.

APPENDIX 1

Questionnaire for Household survey questioner

Demographic character

i General Information of Household

Name of the households ---------- Village name_____

1.1 sex 1= male ----- 2= female ------

1.2 Age of the house hold

1.3 Marital Status of The Household Head

1) Single 2) Married 3) Divorced 4) widowed

1.4 Educational Status 1= illiterate 2= read and write 3= 1- 4 grade 4= 5-8 grade

5= 9-10 grade 6= 11-12 grade 7= Above 12 grade 8= Others,

ii **Family status of house holds**

Size of family members

2.1 Number of male ---------- Number of female ----------

2.2 Family relationship 1) Husband 2) Wife 3) Son 4) Daughter 5) Relative 6) Hired

2.3 Educational level: 1) illiterate 2) read and write 3) 1- 4 grade 4) 5-8 grade 5) 9-10

6) 11-12 grade 7) Above 12 grade 8) Others, if any ____

2.4 Occupation: 1) Farming 2) Wavery 3) Pottery 4) Carpentry 5) Daily laborer 6) Education 7) Petty Trading 8) Others, If Any_____

iii Resource Endowment

3.1 Currently, do you possess your own land? 1. Yes 2. No

3.2 If yes, its total area in---------- ----- Timad

3.3 Area of grazing land---------- "

3.4 Area covered by trees---------- "

3.5 Area under irrigation---------- "

3.6 Area under rain-fed production --------- "

3.7 What is the total area of land you cultivated in 2018/G.C?

3.8 Tot Al irrigated land you cultivated in 2018 G.C? _____

3.9 How do you perceive the condition of your land?

1= Fertile 2= Moderate fertile 3=Less fertile 4=Infertility

iv Water management

4.1 Do you get enough water for irrigation?

1=yes 2=no

4.2 If you yes how do you distribute irrigation water among your selves?

1= on need basis 2=on the basis of farm size

3=time limit 4= simply the user used motor pump in there land

4.3 Who are the responsibilities for coordination of water distribution in the scheme?

1=development agents 2=elderly community leaders 3=water user committee 4=others

4.4 When did you start using irrigation? ---------- Production year

4.5 The source of water for irrigation?

1=River 2=spring 3=modern dam 4=hand dug well 5=others

4.6 What type of irrigation system do you use in scheme?

1= Flooding (traditional.) 2= furrow 3= drip 0r others

4.7 How many times do you produce within a year? ---------- Times

1=one times 2=two times 3=three times in a year

V Market centers accessibility

5.1 What criteria do you consider to decide on the menu of crops to be cultivated in your farm land?

1=Market value 2= productivity 3=social value 4=desirability of home consumption

5.2 Do you have access to information on market prices 1= yes 2= no

5.3 Do you produce crop for market using in irrigation? 1. Yes 2. No

Please give notify if your answer is yes

5.4 Name of the market?

5.5 Distance in kilometers?

5.6 Means of transport?

5.7 Transport cost (Birr) ?

5.8 Commodities sold at the market place ? 1=potato 2= tomato 3=carrot

4= cabbage 5=lettuce 6=others

5.9 What are the problems in marketing your production?

A= Transportation problem C=Too far from market place D=Low market demand

B= Perish ability of the products E= Low price of agricultural produce F= Lack of supply

G= Quality problem H= Others, (specify) ----------

5.9.1 What are the different linkages created due to the implementation of the irrigation schemes in the area? In circle if there are multiple responses

1= Production linkage 2= Employment linkage 3=Consumption linkage

4= Investment linkage 5= Institutional arrangement

5.9.2 Type of crops and price during harvesting {ETB) ?

Type of crops	Before	After
Carrot	20 00	200
Garlic	4500	180
Barley	1200	1200

vi Socio-economic characteristics of the household

6.1 Labor shortage problem in irrigated crop production? 1= Yes 2=No

6.2 If yes, how do you solve labor shortage problem?

1. Family labor 2.By hiring 3. Labor exchange arrangement

6.3 Family labor force fully utilized due to participation in irrigation activity?

1. Yes 2.No

6.4 If yes, please give us the following details

6.5 Age category 1=children 10-13 years 2=children 14-16 3=children 17-50

6.6 Number of family 1=male 2=female

6.7 Activities participated in: 1= Land preparation 2= Sowing 3=Hand weeding

4= Cultivation 5= harvesting 6= ground water well digging

6= Transportation 7= storage 8=marketing

9= Construction 10. Others (specify).....

6.8 Do you use hired labor? 1. Yes 2. No

6.9 how much do you pay for daily laborer during harvesting? 1= 100 2= 120

3= 70 4= covering there dinner and tella + 100 birr and above

vii Provision of Services for Agricultural Production (Extension Service).

7.1 Did you get advisory services from extension agents during the production year 2018 G.c

1) Yes 2) No

7.2 If yes, how frequently do the extension agents visit you?

1=Annually 2= Semi- annually 3= Monthly 4=bi-weekly 5=Weekly

7.3 On which area the advice given?

1=agricultural development 2=animal husbandry 3= Marketing 4=irrigation development

5= new agricultural technologies 6=controlling water distribution 7= all

viii CREDIT SERVICES

8.1 Have you ever used credit for your agricultural activities in 2010/11 production year?

Yes 2. No if no 1= interest rate high 2=no guarantee 3=fear of loan

8.2 if you say yes please give detail source of credit

1=micro finance 2=cooperatives 3= bank 4= local lenders 5= saving and credit 6=others

8.3 purpose of credit 1=purchase grain for food 2= to pay loan 3= to purchase agricultural inputs

4=to purchase farm implements 5=others

viiii Use of Improved Seed

9.1 Did you use Improved Seed during the 2018 G.C production year?

1. Yes 2. No If no, state your reasons _____

1. Not necessary for cultivated crops 2 too expensive 3. Not available

4. Shortage of working capital 5.Lack of credit 6. Specify other reasons

9.2 Agricultural input Purchased during the 2010/11 production year?

No.	Type of inputs	Quantity	Unit price(Birr)	Total price(Birr)
Improved seed				
Barley				
Lentils				
Wheat				
Carrot				
Potato Others				
Fertilizer				

Artificial nasp urea				
pesticide				
Herbicide fungicide				
others				

x **Annual household's income for irrigated vegetable crop production during The 2018Production Year?**

*Vegetable Crops	Cultivated area (timad)	Total annual harvest (Qt)	Consumed (Qt)	Sold (Qt)	Unit price (Birr)	Total price /Birr

Vegetables: 1. Potato 2.. Carrot 3 Cabbage 5.Lettuce 6. Swiss chard cereals ;1. wheat,2. Barley3. Malt barley and others

54 Annual Income And Production In Meher And Bulg Production?

s. no	Crop type	Cultivated crop in hectar	Amount of production in quintal	Unit price in Etb	Total production in ETB	

10.1 What are the major problems encountered by farmers on this scheme? Descending order?

1= pest and diseases 2= (climatic factors) like frost

3= shortage of better quality seeds 4= shortage of fertilizer

5= Market problem 6= herbicide problem 7=all are problem

10.2 What are the positive impacts of irrigation that you have seen?

1= Diversification of crops grown 2 =Increased agricultural production

3= Increased household income 4= Overcome the food insecurity problem

5 = All

10.3 what are the negative impact of irrigation in the scheme if it not properly handle?

1= Improper management of source of canal

2= Silt prob lem 4= water logging on the surface of land

3 =water born diseases

10.4 The household income Source before the implementation of Irrigation

1= Sales of livestock 2= Wage 3= Rent of own land

4 = Sales of crops 5= Relief from government 6= other

xi Livestock holding

11.1 Do you own livestock? 1. Yes 2. No IF yes

Detail / Type									
	bull	Heifer	Cow	sheep	goat	donkey	horse	mule	Hen
Amount in number									

11.2 livestock income 2018

Type	bull		Heifer	Cow	Sheep	goat	donkey	Horse	Mule	Hen
Amount In Birr										

11.3 Do you have enough food for animals? 1= yes 2=no

IF yes source? The source of food for animals

1 = Communal grazing land 2= Crop by-products 3= Concentrate feed

4= Others, (specify)

11.4 Income from sale of livestock by-products during the 2018 production year?

	quantity	amount collected	`amount sold in liter	sold in a year (birr
Milk				
Butter				
Egg				
Hide and skin				
Others(chicken)				
Total Income In birr				

11.4 The contribution of irrigation to livestock? 1=in the boarder we have produce animal feeding

2=crop residual 3=After irrigated we used for grazing

xii House hold consumption expenditure during 2010/2011 production year

Indicate the type and amount of food consumed over the last 7days at your home?

s.no	Food items	Purchased for food Quantity	unit price	Own production Quantity	Unit price

1	Cereals Barley used for injera For Whole roasted tella,qollo				
2	Wheat used for injera Porridge nifro,qollo,bread				
3	Beans9pulses),nifro.ashuk,kik,				
4	oils				
5	Vegetables Onion carrot Potato Lettuce Tomato				
6	Non food items				
6.1 6.2 6.3	Sugar Salt coffee				
7	Livestock products				

12.1 Annual income for different expenditure total

Annual for consumption in birr	For health	Agricultural expenditure	Input	Cloth for family	Eder	For mahber	Recreation	others

xiii **Food Security**

13.1 Have your HH received any food or cash from PSNP? 1= yes, public work beneficiary 2= yes, direct beneficiary 3= no

13.2 If this HH is a direct beneficiary, what are the reasons? 1= HH members are too old to work 2= HH members are too sick to work 3= HH members are disabled 4= other (specify)

13.3 What did you do with the *money/food* you received? 1 = bought staple foods 2= bought clothes 3= paid taxes

4= credit repayment 5= paid for health expenses 6= bought livestock

7= Ate the food 8= all

XIV COPING STRATEGIES

14.1 Which strategies did your household use to cope with food shortage during crop failures?

1) Sale of livestock 3) Sale of Animal product 2) Reduce the number of meals

4) Wage employment 5) rely on less preferred and less expensive foods 6) Other--------

14.2 Have you ever faced any form of shock over the last five years? 1. yes 2. no

If yes, what was? 1 .Drought 2 =.flooding 3= Seasonality of market

4= Mortality and morbidity of livestock 5=other,_____

14.3. Has the shock resulted in/caused hunger in the household? 1= yes 2= No

14.4 If yes, for how long did the hunger period lasted? _____Years

The questionnaires are fully for the academic research purpose and so that any information you provide will be kept confidential.

Thank you

Appendix 2. Interview guide for key informants

1. What is the trend of irrigation activity in the past five years in the district?
2. How do you view the strength and weaknesses, of the irrigation systems? (in relation to technical and social aspects), What are the opportunities and challenges?
3. What are the existing policies in relation to agriculture in general and irrigation in particular and how do you view them?
4. Is there any restriction on the use of existing rivers for irrigation?
5. How do you view the role played by Ethiopian government in irrigation development in the district?
6. What are important strategies for irrigation development in the area?
7. What are the cultural and religious factors that affect the household's economic activity? and their holdings?
8. What is the agro-climatic condition of the study area?
9. What are the major social organizations in the area and what are their roles?
10. What are non-farm activities available in the district?
11. What do you think are the major environmental problems in the area?

Thank you!

Appendix 3 Guiding questions for focus group discussion

1. What are the major opportunities in your local area to utilize small-scale irrigation water?
2. How do you view the strength and weaknesses, of the irrigation systems? (in relation to technical and social aspects)
3. What are the main constraints you face during utilization of small-scale irrigation water in

your local area?

4. Is there any restriction on the use of existing rivers for irrigation?
5. How do you view the role played by the government in irrigation development in the area?
6. What are important strategies for irrigation development in the area? What type of irrigation water source do you think is more advantageous for the community in the area?
7. What are the indicators for wealth ranking according to the local community standards? Is there any relationship with irrigated farming?
8. What are the cultural and religious factors that affect the household's economic activityand their holdings?
9. Discuss the following issues in your group; access to basic school facilities, health facilities, drinking water (for humans & animals), irrigation services, road infrastructure, credit facilities, access to modern farm inputs (fertilizer, improved seeds,pesticides, herbicides, veterinary drugs).
10. What are the major social organizations in the area and what are their roles in irrigated farming?
11. What are non-farm activities available in the district and how do you view its advantage related to irrigated farming?
12. What do you think are the major environmental problems in the area related with irrigation?

Thank you!