ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR FOOD SECURITY STUDIES

THE ROLE OF SMALL-SCALE IRRIGATION IN HOUSEHOLD FOOD SECURITY IN DUGDA WOREDA EAST SHOWA ZONE, OROMIA REGIONAL STATE OF ETHIOPIA

A THESIS SUBMITTED TO THE COLLEGE OF DEVELOPMENT STUDIES CETER FOR FOOD SECURITYSTUDIES OF ADDISABABA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SECURITY

BY

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AUGUST, 2021
ADDIS ABABA, ETHIOPIA

ADDIS ABABA UNIVERSITY

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SCHOOL OF GRADUATE STUDIES

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This is to certify that the senior essay prepared by Yohannes Bekele, entitled" The Role of Small-Scale Irrigation in Household Food Security In Dugda Woreda East Showa Zone, Oromia Regional State Of Ethiopia and submitted in partial fulfillment of the requirements for MSc Degree in Food security complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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DECLARATION

I, Yohannes Bekele, would like to declare that the study conducted on The Role of Small-Scale Irrigation in Household Food Security in Dugda Woreda East Showa Zone, Oromia Regional State of Ethiopia is my original work and that all sources of the materials in the research paper have been duly acknowledged. The study also complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

Yohannes Bekele _____ _____

Name of student Signature Date

As research advisors, I hereby certify that I have read and evaluated the thesis prepared by Yohannes Bekele Cheffa under my guidance, which is titled "The Role of Small-Scale Irrigation in Household Food Security in Dugda Woreda East Showa Zone, Oromia Regional State of Ethiopia.

I recommend that the thesis be submitted as it fulfills the requirements for the degree of Masters of Science in Food security and Development Studies.

Amare Bantider (Ph.D.) _____ _____

Advisor Signature Date

ACKNOWLEDGEMENTS

First and foremost, I thank God for bringing all of these beautiful things into my life.

I'd like to thank my advisor, Dr. Amare Bantider, for his patience, attention, guidance, constructive remarks, and useful ideas throughout the completion of the research work.

I'd also like to thank my brothers, Amare Bekele, Eyobe Bekele, Samson Bekele, and my sister Genet Bekele, and their families, as well as Samson and Mihert Abraham, and their lovely daughters, Henon Samson and Marda Samson, for their financial, technical, and material support. They all provided invaluable assistance to me, and I hope that my gratitude is conveyed to them all. A special appreciation goes to Abaya Alemu for his genuine friendship and assistance in the completion of this study.

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Acronyms

CSA-	Central Statistical Agency
EHNRI-	Ethiopian Health and Nutrition Research Institute
FAD-	Food Availability Decline
FDRE -	Federal Democratic Republic of Ethiopia
FED-	Food Entitlement Decline
FGD-	Focus Group Discussion
GOs -	Governmental Organizations
HFIAS-	Household Food Insecurity Access Scale
Kcal-	Kilocalorie
MRA-	Minimum Recommended Allowance
MOA-	Ministry of Agriculture
MOWR-	Ministry of Water Resources
PASDEP-	Plan for Accelerated and Sustainable Development to End Poverty.
WAO-	Woreda Agriculture Office
WDRMO-	Woreda Disaster Risk Management Office

Abstract

Irrigation can stabilize agricultural production and mitigate the adverse consequences of low or variable precipitation. Small-scale irrigation production will also contribute to fast population growth. Population growth causes farming operations to expand into marginal land, contributing to the destruction of forests, land, and water. The general objective of the study was to carry out a comparative study of the influence of small-scale irrigation adoption and non-adoption on the food security of households. To achieve the set objectives, both quantitative and qualitative methods were used. In the research, there were 73 irrigation adopters from Guyo Gabriel and 74 from Shubi Gemo (n=147), with an equal number of non-adopters, or individuals who did not participate in irrigation. The participants in this study were drawn at random from both groups, for a total of 294 individuals. The main sources of data were household surveys, key informant interviews, focus group discussions, and direct observation. The data collected from the above was analyzed quantitatively by using correlation and regression analyses. For compiling and analyzing the data, multiple regression models were employed. The investigators utilized frequency tables to describe in frequency and percentages the demographic features of the sample respondents. In order to assess the influence of small-scale irrigation on the food security of households, the mean and standard deviation for sample respondents were computed in the woreda. HFIAS (Household Food Insecurity Access Scale) model was used to assess the status of food security among the two groups. Fear of market failure is a constraint to adopting irrigation. 70.7% of vegetable producer households were food secure. 16.3% of them were mildly food insecure, while 7.5% and 5.44% of them were moderately and severely food insecure respectively. 34.1% of irrigation non-adopters were food secure, while 25.1% were mildly food insecure. Another 25.1% of irrigation non-adopters were moderately food insecure, and the rest, 15.6% of irrigation non-adopter households were severely food insecure because they were cutting back on meal size or the number of meals. Agricultural office and stakeholder increase their support for farmers on technical small-scale irrigation adoption issues in order to increase the number of farmers engaged in small-scale irrigation in order to reduce food insecurity households through increased production.

Keywords: small-scale irrigation, household food security

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Food security originated as a term at the United Nations Food and Agriculture Organization's World Food Conference in 1974, with food supply as the core argument. At the 1996 World Food Summit, food security was described as "a condition in which every human being has access to an adequate, clean, nutritious diet, both physical, social, and economic, to meet nutritional requirements and to live an active and balanced life at all times." Food security has emerged as a severe issue, particularly in Africa, where almost 30 million people are food insecure. African countries planned to entirely satisfy domestic food demand by 2030, which is expected to be 70 percent higher than in 2010(2013 Global Agricultural Productivity Report). Governments in sub-Saharan Africa face a challenge in balancing the promises to feed populations. Even though Ethiopia met the MDGs, the number of chronically food insecure Ethiopians was 5.2 million in 2005, (Ethiopia interim country strategic plan (2019–2020), 7.2 million in 2006, 8.3 million later (Dessalegn, 2013), and 7.8 million in 2017. The two objectives that were not accomplished were: gender equality and empowerment and strengthening maternal health. The baseline data on these two goals' metrics revealed virtually slight improvement (FDRE national plan commission, 2017).

Ethiopia has suffered from a lack of food security for the last three decades. The number of food-insecure people in Ethiopia is about 10% of its population and increases to more than 15% during drought years. Agriculture is the leading industry in the Ethiopian economy. The nation is supplied with adequate water supply, with 12 river basins with an average storage capacity of 122 billion m3 of water, plus an estimated 2.6 to 2.65billion m3 of groundwater. The country has ample water resources. About 75% of the national water resources, drains into neighboring countries (MOWR 2001). The country has enough water resources and reserves for the country's long-term future. Ethiopian agriculture is heavily reliant on rainfall, which fluctuates wildly both geographically and temporally. The severity of drought conditions affects the livelihoods of farming

populations and the economy as a whole. According to the Humanitarian and Crisis Resilience Strategy 2018, 7.9 million people in southern and south-eastern Ethiopia require emergency food aid, particularly in pastoral areas. Irrigation is perceived to be a basic policy for alleviating hunger and thus food security. Both the agricultural and particular populations will benefit from raising the agricultural sector's productivity by delivering appropriate food and raw materials at lower prices, generating foreign exchange, and increasing the labor and capital required for industrialization. This study assessed the positive impact of irrigation on ensuring the household food security of small-scale irrigation farmers. It is helpful to turn the rain-fed agricultural system into a hybrid rain-fed and agricultural irrigation system based on rainfall. It is critical to acknowledge the significance of the irrigation sub-sector in the country's growth strategy. It leads to improved livelihoods through improved wages, food security, and the opportunity for jobs, the satisfaction of social needs, and poverty reduction. The power to connect has great significance for irrigation production in Ethiopia to use idle resources. This research paper aimed to analyze the role of small-scale irrigation in household food security. It was to identify critical issues and recommend the most appropriate strategies for potential involvement in the Dugda Woreda irrigation and food security program.

The district has 95,945 acres, of which 60,769 is cultivated land, 3,547 ha of forest land (natural 2,488 ha, plantation 1,057 ha, 3,015 ha of bush and grassland, 12,032 ha of water bodies, 7,987 ha of grazing land, and 11,448 ha of urban area). The research area has a topography of 1,600-2,220masl and an average rainfall of 750mm. The annual average temperature is 26°C.

The agroecology of the area is 55% Kola and 45% Dega. 97.14% flat land and 2.86% derelict land. The soil in the region is composed of 59% sandy loam and 41% clay loam. (CSA, 2013).There are around 2,253 irrigation adopter households who are engaged in irrigation in Dugda woreda.

1.2. Statement of the Problem

In Ethiopia, agricultural production is primarily fed by rain, so it relies on unpredictable and sometimes inadequate rainfall. As a result, there are numerous agricultural production deficiencies. Irrigation can stabilize agricultural production and mitigate the

adverse consequences of low or variable precipitation. Small-scale irrigation production will also contribute to fast population growth (2.6% per year in Ethiopia; CSA 2007). Population growth causes farming operations to expand into marginal land, contributing to the destruction of forests, land, and water.

This depletion of the ecosystem will decrease agricultural production, which in turn aggravates food insecurity and poverty. Any proportion of the burden could be faced by rising productivity rather than comprehensive cultivation to adapt to growing food demand. Irrigation can improve yields and crop quality in Ethiopia (Awulachew et al., 2010), (Nhundu et al., 2010), (Gebremedhin and Peden 2002), and (Hussain2006). Irrigation increases the productivity of farmland and farm production per hectare. It isolates the weather-related disruptions of food insecurity from the national agricultural economy and creates a more secure basis for economic development and poverty reduction. It facilitates the transition of conventional subsistence agriculture into the market-oriented development of high-value crops (Asfaw, 2007). The country has an abundance of water resources and is estimated to have 5.1 million hectares of land that might be exploited for irrigation. However, only around 3% to 5% of irrigable land is currently irrigated. In Ethiopia, irrigation is seen as a fundamental approach to alleviating poverty and, as a result, improving food security. Converting the rain-fed agricultural system, which is dependent on rainfall, into a mixed rain-fed and irrigated agricultural system is advantageous. Irrigated agriculture is becoming increasingly important in addressing food security, employment, rural transformation, and poverty reduction. Most farmers' dependency on rain-fed agriculture has made the country's agricultural economy highly fragile and vulnerable to the effects of weather and climate variability, resulting in complete or partial crop failure, resulting in food insecurity (MoWE, 2011).Agriculture in developing countries continues to be the leading employer of producers. However, low productivity, unemployment, and several threats such as trends and unpredictable demand are set for agricultural jobs. The output of small-scale irrigation practices and equipment, especially in standardized water application, is still too poor for farmers with low agricultural skills, restricted access to financial resources, low production levels, and declining participation. This is because farmers lack the managerial expertise to handle

their irrigation schemes better. The results include reducing crop yield and wastage of water by farmers in irrigation agricultural activities (FAO, 1994). (Alnallem M, 1993).

Farmers' ability and expertise will be harnessed to create an environment that provides job prospects in irrigation practice. The research will then be undertaken to mitigate poverty and enable farmers to address the difficulties of irrigation practices. The Dugda woreda was fitted with lakes and river water supplies, and the administration, NGOs, and farmers set up small-scale motorized irrigation systems. Within this scheme, farmers cultivate field crops and horticultural crops.

The study area's agricultural methods include both animal production and crop production and trade. Crop production accounts for 70% of revenue, while livestock production accounts for 30%. Crops such as maize, wheat, teff, and beans are scarcely produced in the fields. Potatoes, tomatoes, cabbage, and peppers are common horticultural crops. In the study field, livestock such as oxen, cows, sheep, and goats are abundant.

Land crops are mainly rain-fed and rarely irrigated to supplement rainfall insufficiency or complete rain loss. Small-scale irrigation is mainly intended for horticultural crop production. The production of horticulture has decreased in terms of quality and quantity in the market. Although rain-fed crops are typically grown in this region, this research improves the approach and practice of farmers by alleviating their difficulties and showing the prospects of using field crops in small-scale irrigation practices.

Even though many studies have been conducted on the impact of irrigation on household food security in Ethiopia's Oromia region, but no study has been conducted comparative food security status between those who engaged in small-scale irrigation and those who did not engage in the DugdaWoreda. The study is carried out as a comparative study on households' household food security status engaged in small-scale irrigation and those not engaged in it.

1.3. Objectives of the Study

The general aim of the study was to carry out a comparative study of the influence of small-scale irrigation adoption and non-adoption on the food security of households.

1.3.1. The specific objectives of this study are:

1. To assess the level of adoption of small-scale irrigation in the study areas.
2. To investigate the determinant factors of households' adoption of small-scale irrigation agriculture.
3. To assess the disparity in the household food security status of those participating and non-participating in small-scale irrigation.

1.4. Research questions

1. What is the percentage of farmers in the study area that use small-scale irrigation?
2. What are the factors that influence household adoption of small-scale irrigation?
3. What is the difference between in family food security status of farmers in the study area who participate and do not participate in small-scale irrigation?

1.5. The Significance of Study

The effects of small-scale irrigation on household food security are assessed in this study.

It identifies the determinant factors affecting the food security of households and significant small-scale irrigation constraints.

The research offers policymakers and planners an indicator of significant bottlenecks in the involvement of poor farm households in small-scale irrigation and its effect on the study area's revenue. Local managers and NGOs should use the study results to formulate interventions that can help boost the livelihoods of the rural poor and can also serve as a source of credible knowledge. Farmers and policymakers discuss the steps that should be taken to improve the involvement of households in small-scale irrigation and income.

The results of this research can also be used to direct decision-makers and planning planners and who is concerned about small-scale irrigation development for household food security. Additionally, the test results may be used as an input for researchers to further general information. Concepts are relevant to the growth of small-scale irrigation and food security.

1.6. Scope and Limitations of the Study

The analysis is carried out in Dugda woreda, East Showa Zone of Oromia province. The analysis is performed on one woreda with only selected kebeles and focused on a small number of households to assess the collected data accurately and preserve the scope within a defined time and financial cap.

The household survey itself is complex and it is not always free of errors to obtain accurate data, especially on household land keeping, production value, revenue, and the number of livestock, as well as other variables with economic and social consequences. Households can only remember the most recent.

1.7. Ethical Issues

The ethical dilemma of scientific science writing concepts is acknowledged in this thesis and includes:

- Respecting anti-academic fraud laws or anti-plagiarism rules
- Respecting personal rights requires confidentially respecting respondents personally.
- Respecting local and state laws and respecting questions of social morality.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. The Theoretical Foundation of Irrigation as a Concept

In the world, irrigation is a very ancient activity. It is an ancient human pursuit that has been done for several thousand years in several parts. According to the FAO (1997), 30-40% of the world's food supply comes from an estimated 260 million ha of irrigated soil, about one-sixth of the world's agricultural land. For certain crops, irrigated fields produce a higher yield. FAO (2001) also reports that the role of irrigation is well-founded in addressing the problem of food insecurity and in achieving agricultural growth at a global level. Clean irrigation, especially in the less developed parts of Saharan Africa, can and should play an essential role in increasing and stabilizing food security**.**

Irrigation is the artificial delivery of water to crops to allow farming in dry regions and mitigate drought in semi-arid regions. Even in places where total seasonal rainfall is daily, on average, it may be unevenly spread throughout the year and vary from year to year. For the coming year, irrigation is a low-risk alternative to conventional rain-fed farming that can contribute to sustained agricultural output (FAO, 1997).

Small-scale irrigation: This is irrigation on a small scale, typically in small practices. Small farmers have a regulated impact and use technology that they can easily manage and sustain. SSI is characterized by (De Lange et al. (1997). In the construction of conventional irrigation systems that are used as a supplement to the production of rain-fed crops, mainly horticultural crops. Therefore, small-scale irrigation is handled by farmers: farmers must be interested in the planning process and, in particular, in the decision-making process about the borders, the construction of the canals, and the placement of the outlets and bridges. While certain small-scale irrigation systems serve an individual farm household, most serve a community of farmers.

Ethiopian Irrigation Adoption: A Historical Overview

Sulas et al. (2009) identified insufficient information regardless of water management of rain-fed agriculture in their study to explore if irrigation was a crucial element in state

formation and urban growth in the ancient civilization of Axum, Northern Ethiopia. Traditional irrigation, on the other hand, has been practiced in Ethiopia for generations (Bekele et al., 2012). Furthermore, irrigation technologies have been utilized to grow subsistence food crops in Ethiopia's highlands since ancient times (Awulachew et al., 2007; Bacha et al., 2011; MoA, 2011a). Various writers, including Awlachew et al. (2007), Makombe et al. (2007), Hagos et al. (2009), and Bacha et al. (2011), emphasized that smallholder farmers in Ethiopia have used supplementary irrigation for millennia to solve their livelihood difficulties.

This irrigation technique has been utilized to collect water from flash floods that have been inundated by bigger catchments on higher streams. These ancient irrigation systems were constructed and maintained by creating a water users' organization for tasks such as construction, water allocation, operation, and maintenance, which was led by individuals (Belay and Bewket, 2013). This organization is made up of up to 200 users divided into 20 to 30 farmer groups that share a major canal or one of its branches (MoA, 2011a). Even though "irrigation began in Ethiopia during ancient times," (Awlachew et al., 2007; Makombe et al., 2007; Hagos et al., 2009; Bacha et al., 2011)

Modern irrigation was initiated in the early 1950s as a result of a bilateral arrangement between the Ethiopian government and the Dutch firm known as HVA-Ethiopia sugar cane plantation (MoA, 2011a; Bekele et al., 2012). The majority of Ethiopia's traditional irrigated areas are supplied mostly by surface water sources, whereas groundwater utilization has just recently begun as a trial project in the East Amhara region (MoA, 2011a). The Rift Valley is where modern irrigation in Ethiopia began, particularly in the Awash River Basin, where pump irrigation was first used. Academia Journal of Agricultural Research; Haile and Kasa; Surface irrigation methods for cotton and wheat cultivation, as well as commercial crops such as bananas, 266 mainly furrow irrigation and basin irrigation technologies, were used. Similarly, Awulachew et al. (2007) explained that irrigated agriculture began in Ethiopia in the upper Awash Valley to produce industrial crops such as sugarcane, cotton, and horticultural crops on a large scale, explaining the remarkable emergence of irrigation development and the establishment of agro-industrial centers. This was owing to the use of the Koka Dam, which was built to provide a reservoir for agricultural water supply, flood control, and

hydropower generating. Windmills and hand pumps were installed in the mid-1970s to raise water from groundwater for drinking water supply, household, and gardening applications (MoA, 2011a). According to the Ethiopian Ministry of Agriculture, sophisticated water storage and management systems for irrigation are in place. Water diversion projects, water storage dams, micro-irrigation, rainwater collection methods, as well as shallow groundwater harvesting techniques, are all instances of this. These systems employ various water-drawing irrigation technologies to lift, transport, and apply irrigation water for irrigation purposes. There are night water storage facilities, treadle pumps for raising water, smallholder drip systems, and micro-sprinklers for irrigation application, among other things (MoA, 2011a).

According to the Ethiopian Ministry of Water Resources (MoWR), irrigation development in Ethiopia is categorized into three kinds based on the size of the area:

1. Irrigation systems on a small scale, less than 200 hectares ha

2. Irrigation systems on a medium scale (200-3,000 ha)

3. Irrigation systems on a large scale (more than 3,000 hectares)

This is the most widely used categorization system in Ethiopia. As a result, 46 percent of projected irrigation improvements are for small-scale irrigation (Makombe et al., 2011). Irrigation development in Ethiopia is also characterized by a combination of the history of establishment, management system, and structural type, as follows:

1. Traditional irrigation schemes: These are small-scale irrigation systems that often use diversion weirs made of locally available materials and require annual maintenance.
2. Modern schemes: These are small-scale irrigation systems with concrete diversion weirs that don't need to be maintained on a yearly basis.
3. Government-run: These are large-scale operations built and controlled by the government. Out-growers (smallholder farmers who have farms near large-scale systems) are sometimes supported by these programs.
4. Private: These are privately owned automated agriculture systems that require highly intensive operations. These two classification systems, among others, are the most

widely used in Ethiopia. Various players in the field have adopted this methodical categorization.

Smallholder farmers in Ethiopia cultivate over 95 percent of the total cropped land and generate over 90 percent of the total agricultural production. In Ethiopia, the average landholding size of 1.18 hectares per household farm (CSA, 2007/08) complies with the traditional sense of small farming (less than two hectares per household). Smallholder farmers in Ethiopia also have resource limitations, including lack of inputs, and technology, household labor dependence, livelihood vulnerability, and perceived risk, such as lower yields, crop failures, and poor pricing (Betre, 2006; Mahelet, 2007). The main reason for this is that these households typically meet the other aspects of smallness, such as limited access to services such as money and technology; divided land ownership; high-risk exposure; and survival orientation. Growing agricultural yield per plot, increasing the area of arable land, and increasing crop quality are the three strategies for increasing food security (number of crops per year).

The Concept of Food Security

International organizations and scholars describe food security in distinct ways. At the World-Wide Food Summit, 1996, the concept of "food security" was described as "at the individual household, global, national, and local level, when all people have physical and economic support to be active and balanced, and access to adequate, safe, and nutritious food at all times to satisfy their nutritional requirements and food preferences" (FAO, 2010). At present, a combination of these concepts, focusing on availability, access, usage, and stability, serves as a working concept for international organizations' programs. Food security is a notion that has developed dramatically over time. Most of the concepts of food security differ from the one suggested by the World Bank (Maxwell, 1996), where food security is characterized as access to adequate food for an active, safe life for all people at all times (World Bank, 1986). Availability (adequate supply of food); access by household production, purchasing in the market or movement of food; reliability where availability and access are assured at all times; and usage relating to the necessary biophysical requirements (good health) needed for the adequate use of food to satisfy particular nutritional needs and protection are important elements of the concept

(Maxwell and Frankenberger, 1992). The availability of food ensures that adequate amounts of acceptable, essential types of food produced domestically, industrial imports, or food assistance are regularly available to or in inappropriate proximity to individuals. It is the amount of domestic food supplies, net commercial imports, food assistance, and domestic development at the national level. Individuals have sufficient access to food because they have adequate wages or other means to buy or barter for adequate food amounts required to sustain an adequate level of diet/nutrition intake. Food stability refers to the consistent supply of enough food throughout the year without shortages (Jrad et al., 2010). To be food secure, a community, household, or single person must always have access to enough food. As a result, the term "stability" can apply to both the availability and accessibility components of food security.

2.2.1. Demographic theories

The relationship between population development and food supply is the core issue of demographic theory, in which there are two divergent and conflicting hypotheses about their relationship. The first argument is the Malthusian viewpoint, which seeks to create food shortages and suggests that unchecked, excessive population growth is the source of food shortages.

However, the Malthus theory faces criticism from numerous scholars as the theory fails to allow the means to boost household food security (Degefa, 2005).

The second hypothesis finds high population growth to be a beneficial stimulant for economic and social progress, under which Easter Boserup's works are noteworthy (Boserup, 1965). It considers population growth to be a factor, encouraging the acceptance and spread of technological advances that increase agricultural productivity while reducing food poverty and hunger vulnerability. She claims that by making financially viable investments in irrigation, electricity, transport, and improved manufacturing technology, the beneficial impact of population growth can be achieved (Degefa, 2005). The two hypotheses in the study of population development and food security are the most competitive theories.

2.2.2. Climatic Theory

Droughts and floods are regarded by climate science as causes of crop failure and contribute to food shortages in areas of rain-fed agriculture. Both shortages and abundant water have detrimental effects on the development of crops and livestock, which are the main livelihoods of farm households. Drought and floods have triggered multiple catastrophes in sub-Saharan Africa and South Asian countries, causing the deaths of millions of people (Degefa, 2005).

The Ethiopian famines of 1958, 1973, 1984, and 2002-2003, for example, are partially explained by drought and subsequent crop shortages, and significant livestock deaths. Drought also contributes to a decrease in rural jobs and a dramatic increase in market food prices, which, in turn, contributes to the issue of food availability through market transactions. Different concerns about food quality may also be linked to climate issues.

2.2.3. Models of Food Insecurity Analysis

While general descriptions of the cause of the famine are plentiful, the connections between them are sometimes imprecise or often unstated. The general theories need to be mediated by models of food insecurity to measure household food security mechanisms and forecast the correct effects (Getachew, 1995).

The state of household food security in rural areas is about whether households will produce enough food from their own production or sell livestock and purchase food grains. There must be adequate food available, and households must purchase it (Degefa, 2002). Therefore, household food security implies complementarity with the supply and entitlement of food. The Food Available Decline (FAD) and the Food Entitlement Decline (FED) are two contrasting models of food insecurity.

2.2.3.1. Food Availability Decline Model (FAD)

The model of the decline in food availability is aimed at identifying the key barriers to improved agricultural production, which in turn has led to a decline in food availability. The essential point of this hypothesis is that something that disturbs food production,

such as droughts and floods, induces starvation by limiting food supply for an extended period (Getachew, 1995).

The reasoning behind this argument is that drought or flooding leads to crop loss and livestock mortality, thus decreasing the food supply. The model, however, is criticized as the supply of food at global and national levels could not contribute to household and individual food security. Therefore, the model alone does not guarantee a proper study of food security at the level of households since it focuses on food supply availability rather than food demand (Degefa, 2002).

2.2.3.2. Model of Food Entitlement Decline (FED)

The model of the Food Entitlement Decline was created by Amarty Sen (1981). The core point of this model is that the mere existence of food in the economy or on the market does not entitle an individual to eat food (Getachew, 1995) and that famine will occur without a reduction in overall supply. Access to food plays a crucial role in gaining power over food, which is decided by four sources of rights: production, trade, own labor, and transition, Sen believes (Sen, 1981).

Based on the degree of risk, the FED has the potential capacity to classify which categories of individuals are impacted by various risks to the food supply or access separation (Degefa, 2005). Because of its power, the FED model still has some pitfalls to resolve before explicitly implementing it as a paradigm for studying food safety.

The exclusion of assistance entitlements (food aid), firmly based on food scarcity, and the belief that malnutrition deaths are exacerbated by poverty, disregard of cultural expectations and tastes of food intake, and the like, were not considered by the FED hypothesis.

2.3. Empirical Literature

2.3.1. Contribution of Irrigation to Household Food Security

Getaneh (2011) argues that irrigation plays a vital role in stabilizing agricultural production and mitigating the detrimental consequences of variable or inadequate rainfall. Both yields and crop quality can also be improved (Getaneh, 2011) (Awulachew et al., 2010).

According to FAO (2010), as cited in Jemal (2019), the value of per hectare crop production in irrigated settings is about twice that of rain-fed settings.

Household income and consumption are much higher in irrigated settings than in rain-fed settings, and a 50 percentage point gap is standard. Investments in irrigation will have broader impacts on food security and poverty reduction if attempts are made to revitalize and upgrade existing conventional SSI systems, with funding for improved access to data supply, output marketing, and extension to promote access to information and creativity (Awulachew et al., 2010). Similarly, the impact assessed by Desta in 2013 showed that irrigated farming's contribution to income in highly irrigated settlements is about 70 percent compared with 60 percent in two other low-irrigated settlements. At the same time, the absolute size of agricultural production is still the largest in the heavily irrigated village, considering the smaller size of land ownership and cultivated holdings by more than 30% over the low-irrigated village. The highly irrigated village has a higher per hectare agricultural income of over 50 percent than the low-irrigated village.

Compared to subsistence farming, the cash crop economy with substantial cash flow provides a wide array of off-farm revenue opportunities (Kelilo et al., 2010). Compared to the situation before introducing the schemes, irrigation schemes improved household income and thus improved household food security (Mengistu, 2007).

Increased production, revenue, diet diversification, and decreased hunger months from 6 to 2 months (July and August) resulted in the construction of small-scale irrigation schemes, increased crop diversity, and a change from the cereal livestock system to the cereal-vegetable-livestock system (IFAD, 2011). Through increased demand, higher yields, lower chances of crop failure, and higher farm employment throughout the year, irrigation benefits the vulnerable (Asayehegn, 2011; et al, 2015). Farmers may diversify their planting patterns with irrigation and move from low-value staple agriculture to more valuable, market-oriented output using irrigation. Increased production makes food affordable and cheap for the poor. Irrigation improves livelihoods by improving incomes, food security, employment prospects, addressing social needs, and reducing poverty (MoARD, 2012).

Participation in the use of irrigation raised annual household agricultural income by 19,474.8 birrs for participating households relative to non-participating households and their possession of physical properties, estimated at 27502.4 ETB (Legesse et al., 2018). In general, irrigation water is an essential resource for many agricultural and livelihood practices and positively alleviates poverty (Worku, 2011).

The production of irrigation and management of agricultural water has considerable potential in every country to increase productivity and minimize susceptibility to climate instability (MoFAD, 2012; MOFAD, 2013). They recognize the role of the agricultural sector, including the irrigation sub-sector, in the country's overall economic growth. And in achieving the goals of the rural development policy and strategy, different donors and development partners should be active in providing technological and financial assistance to boost food security and alleviate poverty. Many scholars claim that the most promising options for achieving food security in Ethiopia are to increase crop quality and agricultural yield through different methods and technologies (such as irrigation).

2.3.2. Factors Affecting Household Food Security in Ethiopia.

In several areas of the country, a combination of natural and artificial causes have contributed to this severe and rising issue of food insecurity. The immediate causes of food insecurity include regular droughts and periodic trends in rainfall, destruction of habitats, rapid population growth, and the low levels of technology used in agriculture and the resulting low sector productivity, weak rural infrastructure, and legacies of past policy constraints are also seen as fundamental causes of food insecurity and widespread poverty in the country (MoARD., 2007).

Demand volatility, low non-farm jobs, low wages, regional market heterogeneity, high levels of natural depletion, low levels of agricultural technology, high levels of illiteracy and insufficient standards of primary education, poor health and sanitation, high population growth, and poor governance are other factors contributing to trapping Ethiopia in the current state of food insecurity and poverty (Asefa, 2012). According to ECHA (2014), food security is worsening overall as a result of poor rains, both in livestock holdings and farming areas, and locust swarms have impacted food production in the country's eastern regions. Ethiopia is a region vulnerable to disasters. The country's

nearly 12 million inhabitants are routinely vulnerable to droughts, flooding, landslides, epidemics, and earthquakes. These frequent shocks have many detrimental effects, such as forced internal population relocation, the loss of infrastructure and livelihoods, widespread hunger, food shortages, and extreme food instability.

The Erratic Rain, loss of agriculture due to population pressure, soil degradation, lack of oxen, poor rates of diseases of sheep, frost, and drainage of water, and insect and plant disease issues. The problem of food insecurity has been caused by low soil productivity, land scarcity, frost attacks, a persistent shortage of cash income, inadequate farming technology, insufficient extension facilities, high labor loss, and poor social and infrastructural conditions (Berhanu, 2007; Tilaye, 2010; Hussein, 2013).

Many surveys in the past have shown that Ethiopian people have endured long stretches of food shortages that could be due to several causes, including periodic droughts and farmland destruction. For most people, these factors have restricted "physical, social, and economic access to sufficient, safe, and nutritious foods to satisfy nutritional requirements and food preferences to lead an active and balanced life" (Gilligan et al., 2011). Land depletion, combined with erratic rainfall and drought, is creating a severe food security issue for households in Ethiopia. Also, overgrazing, improper farming methods, and farm resource mismanagement are the significant causes of food insecurity (ATA. 2011).

The fundamental causes of food insecurity in the country were population growth and resource shortages, limited land ownership, farmers' expertise and low levels of schooling, inefficient production processes and marketing services, the volatility of drought and flooding, urban growth, unemployment outside the farm and traditional, social and cultural influences (Woldeamanuel, 2009).

In this respect, various scholars accept that the causes of the current issue of food insecurity in Ethiopia are myriad and interrelated. These include rainfall fluctuations, soil depletion (Woldeamanuel, 2009; ATA. 2011; AFI., 2012; Bewket, 2012), inadequate storage facilities, loss of pre-and post-harvest crops, household inability to buy food, limited and scattered land size, lack of potential for off-farm income, sub-sector livestock under production, insufficient credit and extension programs, and instability in tenure

(Bewket, 2012). Similarly, in the second half of the 20th century, several of the most severe food shortages were triggered by a mixture of many causes. Drought and other extreme weather conditions, rodents, animal diseases, and other agricultural problems, climate change, military wars, lack of emergency planning, corruption, and political unrest have been the most common causes of food insecurity in the world-dependence on cash crops, subsidies, and fast population growth (AFI, 2012).

2.3.3. Ethiopian Food Security Situation

In the past, Ethiopia was closely linked to extreme recurrent food shortages and famine, as reported in Dessalegn (1991), cited in Mesay (2008). Adverse climate changes, combined with high demographic pressure, environmental pollution, and technical and structural causes, have contributed to a decrease in per capita landholding size, contributing to a severe rise in the problem of food security in Ethiopia (PASDEP, 2005). The decline in per capita income and food production in Ethiopia and most sub-Saharan African nations has led to food insecurity (Sisay, 1995; Getachew, 1995). Linked recurrent drought and the long-term secular decline in resource endowment to Ethiopia's food insecurity issue. Similarly, FDRE (2002) reveals that Ethiopia's cause of food insecurity is connected to unusual and man-made shocks, such as drought and lack of productive property. There is currently a rising opinion that food shortages and hunger issues are directly connected to the situation in Ethiopia. Among those countries in Sub-Saharan Africa with the most severe long-term food conditions, Ethiopia is classified as. Various historical reports have shown that, with several rain shortages and significant loss of livestock, Ethiopia has experienced some 44 severe famine catastrophes.

Around 8 million people in Ethiopia were affected, and an estimated 1 million died (Webb and von Braun, 1994; Degefa, 2005). According to Devereux (1993), the term famine is used to describe severe food crises, and it is referred to as the worst manifestation of food insecurity. Sen (1981) indicates that when people can't regulate when they affect subsistence production, hunger prevails.

2.4. Conceptual Framework

2.4.1. Factors Influencing Household Food Security and Irrigation Adoption

Generally, irrigation water is a vital resource for many products and livelihood activities and positively affects poverty alleviation (Worku, 2011). In every country, irrigation and agricultural water management may considerably boost productivity while reducing sensitivity to climate instability (MoFAD, 2012; MOFAD, 2013). In recognition of the importance of the agriculture sector, including the irrigation subsector, in the country's overall economic development and in realizing the objectives set in the rural development policy. And strategy, various donors and development partners should be engaged in providing technical and financial support towards improving food security and alleviating poverty. Many researchers argue that increasing crop quality and agricultural yield through various methods and technologies (like irrigation) are the most viable options for achieving food security in Ethiopia. Abonesh (2006) conducted a study in eastern Showa using Hickmann's two-stage analysis, revealing that those households with access to irrigation are in a better position to secure enough food than their counterparts. In the North Shoa Zone title irrigation project, Azemer (2006) also looked at food security and the economic effects of irrigated farming. His research findings showed the better efficiency of irrigated agriculture in crop production and productivity than rain-fed agriculture. Hagos et al. performed research (2009) also suggested that irrigation improved yields per hectare, revenue, consumption, and food security in Ethiopia.

The problem of food insecurity has been caused by low soil productivity, land scarcity, frost attacks, a persistent shortage of cash income, inadequate farming technology, insufficient extension facilities, high labor loss, and poor social and infrastructural conditions (Berhanu, 2007; Tilaye, 2010; Hussein, 2013). Many surveys have shown that Ethiopian people have endured long stretches of food shortages that could be due to several causes, including periodic droughts and farmland destruction. Individuals have a better, more active lifestyle, access to safe and nutritious foods physically, socially, and economically to fulfill nutritional needs and dietary preferences (Gilligan et al., 2011). Land depletion, combined with erratic rainfall and drought, creates a severe food security issue for households in Ethiopia. Also, overgrazing, improper farming methods, and farm resource mismanagement are the significant causes of food insecurity (ATA. 2011).

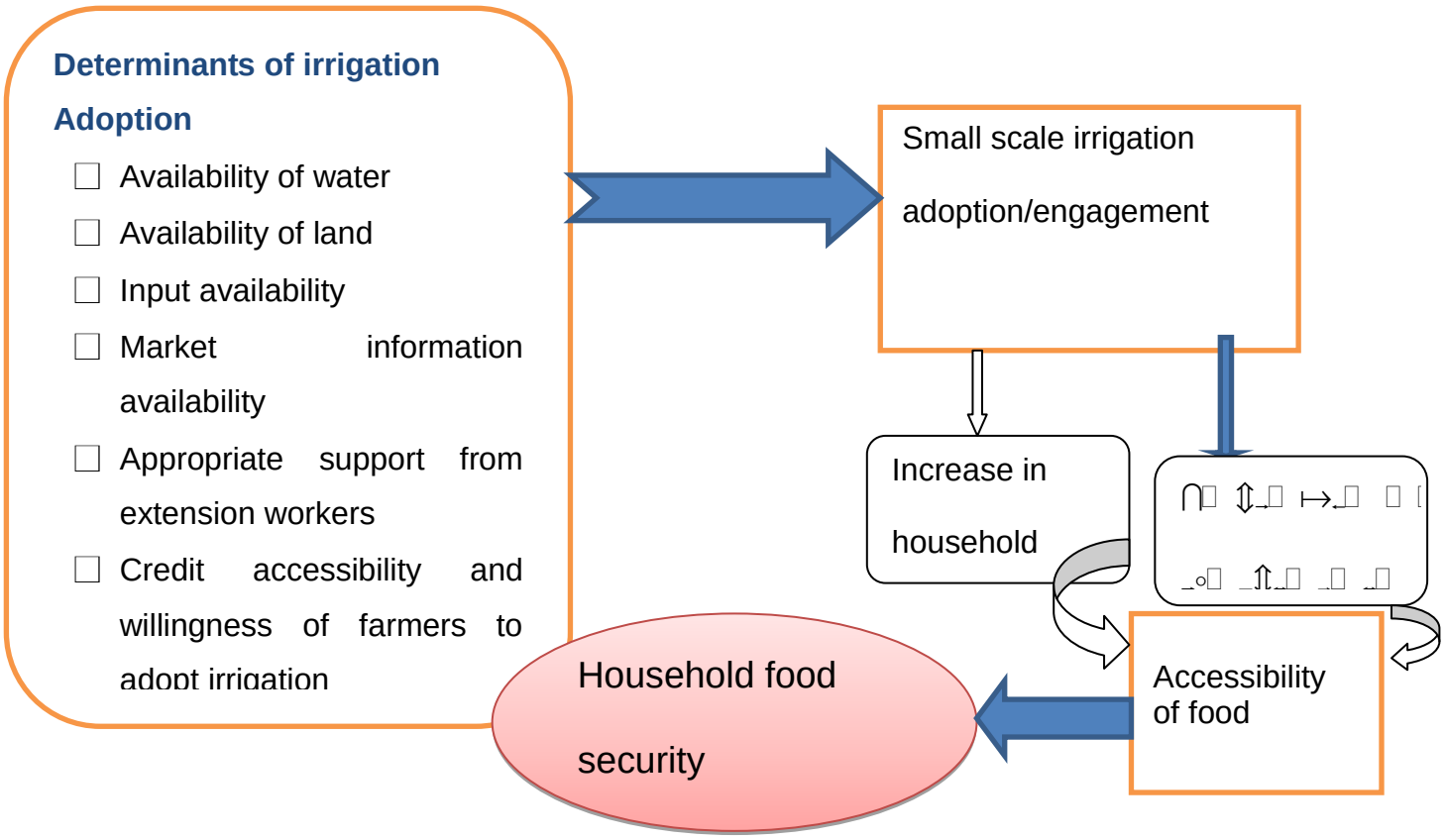

Figure1: Conceptual framework of the role of small-scale irrigation in household the food availability dimension of food security

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of Dugda Woreda

Dugda district is one of the 25 districts in the East Shewa zone, Oromiya Regional States, Ethiopia. The capital town of the district is Meki. It is located 130 kilometers from Addis Ababa (Fin Fine) and 90 kilometers from Adama. The district shares boundaries with Ziway-dugda to the east, the South Nation, and the Nationalities and Peoples Region to the west, Bora to the north, and Adami Tulu judo kombolecha to the south. According to the Dugda District Agricultural Office, the district lies between 7o 58 'N and 38o 43' E, and the altitude ranges from 1600 to 2220 masl in the great rift valley of Ethiopia (CSA, 2008).

The total population of the Dugda woreda was estimated at 185,484 in 2020. The majority of the population claimed to practice Ethiopian Orthodox Christianity, while 3.88 percent of the population claimed to be Protestant, 2.13 percent of the population claimed to be Muslim, and 1.36 percent of the population claimed to practice traditional religions (CSA, 2008).

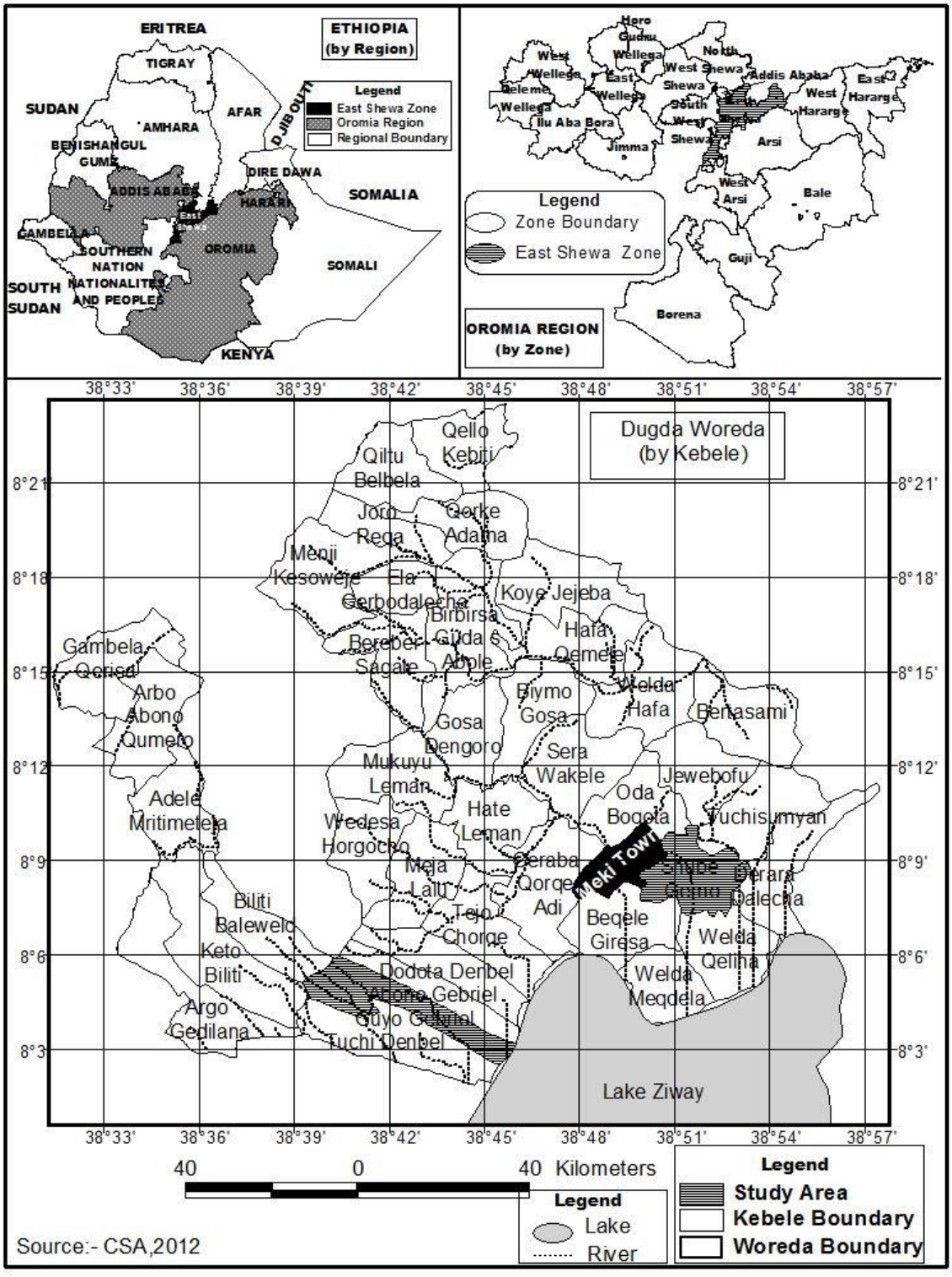

Figure 2: study area Map

3.2. Research Design

During this study, both quantitative and qualitative methodologies were employed. a combination of approaches A research design may include philosophical assumptions as well as techniques of investigation.As a technique, it involves philosophical assumptions that guide the direction of the gathering and analysis of information and, therefore, the mixture of qualitative and quantitative approaches in many phases of the research process. It is a method for collecting, evaluating, and integrating quantitative and qualitative data in a single or series of research. Its core idea is that combining quantitative and qualitative methodologies yields a significantly more comprehensive knowledge of research challenges than either strategy alone (Cresswel, 2003).

3.3. Sampling techniques and procedures

Rural farmers in Dugda woreda who have participated in small-scale irrigation and who do not participated in small-scale irrigation simply in rain-fed agriculture were chosen as the frames for this comparative analysis. The study area was chosen deliberately and carefully to reflect on the Woreda regarding food security, economic, socio-cultural, and physical variables such as connectivity to infrastructure services, natural resource endowment, and the like. This study mainly focuses on farmers who participate in small-scale irrigation and those who don't participate in small-scale irrigation. For some of these factors, the study area was selected. The familiarity of the researcher with the study area and the distribution of irrigation farms causes them to select purposefully. Also, to pick the representative samples, a multi-stage sampling method was used. Rural kebeles were classified in the first stage based on the extent to which farmers participated in small-scale irrigation.

Besides, the representativeness and accessibility of getting data from respondents were significant factors in selecting the study area. Hence, it is an appropriate technique to have a deep understanding of the role of small-scale irrigation in ensuring the household food security of the study area. Purposive sampling necessitates the selection of individuals who are informed about the topic at hand due to their engagement in and familiarity with the scenario. The study kebeles were selected purposively based on the

number of small-scale irrigation adoption (vegetable producers), closeness to the main road, and familiarity of the researcher with the study area.

3.4. Data Types and Sources

Primary and secondary data sources were used. The main sources of data primary were household surveys, key informant interviews, focus group discussions, and direct observation. The study may also include secondary data from published and unpublished materials like books, journal, maps, national and regional manuals, and guidelines related to the topic to be studied**.**

3.5. Methods of Data Collection

Primary data was collected using a variety of information gathering methods, including household surveys, focus group discussions, and key informants.

3.6 Methods of Data Analysis

3.6.1 Descriptive analyses

In this thesis, qualitative data like key informant interviews, FGD, and observations were analyzed qualitatively. The process of describing or summarizing a collection of data using statistical techniques is known as descriptive analysis, also known as data analysis or descriptive statistics. Descriptive analysis, as one of the most common types of data analysis, is well-known for its ability to extract useful insights from otherwise interpreted data.

3.6.2 Inferential analyses

In this thesis, quantitative data was analyzed quantitatively as well as inferentially. Inferential statistical analysis includes objectively and quantitatively summarizing data, determining if data patterns are significant, and drawing conclusions regarding system performance.

3.6.3 Regression analysis

In statistical modeling, regression analysis is used to determine the relationship between an outcome or response variable and a dependent variable. Forecasters ("offering responsible factors" or functionality). Using a logistic regression model, you may find out how a categorical dependent variable is related to a collection of independent factors.

When the dependent variable has only two values, such as 0 and 1 or Yes and No, it is referred to as logistic regression. When the dependent variable contains three or more distinct values, such as married, single, divorced, or widowed, the method is called multinomial logistic regression. However, even if the dependent variable's kind of data is different from that of multiple regression, the procedure's practical application is the same. In the examination of categorical answer variables, logit regression is in competition with discriminant analysis. Many statisticians believe that logistic regression is more flexible and more suitable for modeling most scenarios than other methods of statistical analysis. As a result, discriminant analysis is performed.

The data collected from the above were analyzed quantitatively by using correlation and regression analyses to make it easy to interpret. For compiling and analyzing the data, multiple regression models were employed. The data obtained were evaluated using statistical techniques once full questionnaires were received. SPSS-version 20 was used to process the survey data. The data was coded, synthesized, and afterward forwarded for analysis and presentation to SPSS Version 20. The investigators utilized frequency tables to describe in frequency and percentages the demographic features of the sample respondents. To assess the influence of small-scale irrigation on the food security of families, the mean and standard deviation for sample respondents were computed in the woreda. Logistic regression was applied to explain the association of independent variables with dependent variables. Model of HFIAS (Household Food Insecurity Access Scale). Each of the questions in the HFIAS is asked during a recall period of four weeks (30 days). The respondent is first asked an incident question, which asks whether the event in the question occurred at all in the previous four weeks (yes or no). Suppose the respondent responds "yes" to an incident query. In that case, a frequency-of-occurrence question is posed to decide if the condition infrequently occurs (once or twice), seldom (three to ten times), or, in the preceding four weeks, often (more than ten times). It can be used to assess the prevalence of household food insecurity (access component) and to detect changes in the food insecurity situation overtime for the study area analyzed quantitatively. The collected data was analyzed and compared to the secondary data from the literature to assess the effects of small-scale irrigation on household food security in the study area.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

Data were collected from 147 irrigation adopters and an equal number of irrigation non-adopters. In this study 294 people took part in the survey. Concerning the age categories of respondents, 2.7% of household heads were under the category of 20-30 years, while 31.3% and 65.95% were under the age categories of 31-40 and 41-50 years, respectively. On the subject of the marital status of respondents, 98.65% of them were married, and 1.35 were divorced. 82.7% of respondents were male, and 17.3% of them were female. 34% of households had five children per household. 25.1% and 21.75% of them had four and three children, respectively. 1.35% had one child per household, and 16.3% had two, while 1.35% had more than five children.

Concerning the educational status of household heads, 1.35% of them couldn't read and write. 45.6% of them were able to read and write. 21.45% and 11.5% of them attended grades 6-8 and 1-5, respectively. 18.7% of them appeared in grades 9-12, and, finally, 1.35% of them completed college. In terms of respondents' occupations, 98.6% were farmers, and the rest, 1.35%, were government employed. Vis-à-vis the monthly income of household heads, 91.8% of irrigation is non-adopted.

The rest got a monthly income of 500-1000 Ethiopian Birr and the rest, 8.2%, got 1001-2000 Birr. All irrigation adopters earn 3001-4000 Ethiopian birr per month (Table 1). This income status of households indicates that 91.8% of irrigation non-adopters get an annual income of 6,000-12,000 Ethiopian Birr, while 9.2% earn an annual income of 6001-12,000. However, irrigation adopters get an annual income ranging from 12001 to 24,000. This income status of households is consistent with the findings of a study conducted in the Sidama zone (Tizita, 2017), which revealed that irrigation user households earned a mean annual income of 13309.10 ETB (665.6 USD) from cash crop production, while irrigation non-user respondents earned a mean annual income of 9213.77 ETB (460.7 USD). This demonstrates that irrigating families make more money from crops than non-irrigating ones. According to the findings of this study, irrigation adopters made more money than non-adopters.

Table1: Socio-economic and demographic status of the study population

Variables	Category	Adopters	Non-adopters
		No. (%)	No. (%)
Age group of respondents	20-30	5.4	00
	31-40	29.9	32.7
	41-50	64.6	67.3
	Total	100	100
Marital status of respondents	Married	97.3	100
	Divorced	2.7	00
	Widowed	00	00
	Widower	00	00
Sex of respondents	Male	81	84.4
	Female	19	15.6
The Number of children per household.	One	2.7	00
	Two	16.3	16.3
	Three	20.4	23.1
	Four	23.1	27.2
	Five	34.7	33.3
	>Five	2.7	00
	Six	00	00
Religion of respondents	Muslim	41.5	29.9
	Orthodox	58.5	70.1
	Total	100	100
Education Level of respondents	Can't read and write	00	2.7
	Read and write	48.3	42.9
	Grades 1-5	5.4	17.7
	Grades 6-8	13.6	29.3
	Grades 9-12	29.9	7.5
	College	2.7	00
Occupation of respondents	House wife	00	00
	Farmer	97.3	100
	Gov't employee	2.7	00
	Merchant	00	00
	Daily laborer	00	00
Monthly household income (ETB)	500-1000	000	91.8
	1001-2000	00	8.2
	2001-3000	00	00
	3001-4000	100	00
	>4000	00	00

The result shows that occupation and irrigation adoption had an association. The Chi-square value is significant because it was less than 0.005 (Table 2).

Table2: chi2 rn respondents occupation

Occupation of respondents	Irrigation adopter and non-adopters		Total
	Adopters	Non-adopters	
Farmer	143	147	290
Gov't employees	4	-	4
Total	147	147	294
Pearson chi^2 =18.83 pr= 0.000			

There is a significant difference between adopters and non-adopters at a 5% significant level. Of the given respondents, 86 of non-adopters and 69 of adopters are married.

Table3: Chi square of vegetable producers and non-producers on sex categories

Sex of respondents	Irrigation adopters and non-adopters		Total
	adopters	Non adopters	
Female	59	18	77
Male	88	129	217
Total	147	147	294
Pearson chi square=29.5 pr=0.000			

The incom status of irrigation adopters and non-adopters has varied. This indicates that irrigated production has a significant role in the increament of a household's income.

Table 4: Associations of household head and vegetable production

Group	Obs.	Mean	Std. Err.	Std.Dev.	95%conf.	Interval	
Non-adopters	147	11574.74	1386.641	16812.12	8834.261	14315.22	
Adopters	147	9689.626	1241.694	15054.34	7235.61	12143.64	
Combined	294	10632.18	930.7092	15958.34	8800.461	12463.91	
Diff		1885.116	1861.337		-1778.221	5548.452	
Diff=							
Diff=Mean(non-adopters)-Mean adopters Ho:Diff=0 Pr (T<t)=0.88440 pr(T>t)=0.1560 Ha:diff=0							

4.2. Irrigation Adoption Status of Households

The results showed that 97.3% of irrigation adapters were produced twice a year, and all non-adopters said they were only once a year. According to data from table 2, irrigation adapters produce mainly fruits and vegetables twice annually, while all irrigation non-adopters produce crops. The main water sources were the lake (18.4%) and groundwater (81.6%) for irrigation adopters, and all irrigation uses rain as a source of water. All irrigation non-adopters had a plot size of less than 1 ha, and 25.2% of irrigation adopters owned a plot size greater than 1 ha, and 74.8% of them had a plot size of less than 1 ha.

Table 5: Irrigation adoption status of households

			Frequency	Percent
How many times are produce	Irrigation adopters	One time	4	2.7
		two times	143	97.3
		Total	147	100.0
	Non-adopters	One time	147	100
		Two times	00	0
		Total	147	100
What are the main products you produce?	Irrigation adopters	Fruits and vegetables	147	100
		Crops(using rain)	147	100
	Irrigation non-adopters	Vegetable and fruits	00	0
		Crops(using rain)	147	100
Plot size	Irrigation adopters	0.25 and less>1ha	14	9.5
		0.5-1ha	23	15.6
		1ha-1.25ha	62	42
		1,25ha-2ha	34	23.1
		>2ha	14	9.5
	Irrigation non-adopters	0.25 and less	00	00
		0.25-1ha	00	00
		1ha-1.25ha	133	90.4
		1.25ha-2ha	14	9.6
		>2ha	00	0
Sources of water for production	Irrigation adopter	Rain	147	100
		Lake	27	18.4
		Ground water	120	81.6
	Irrigation non-adopters	Rain	147	100
		Lake	00	00
		Ground water	00	00
		Total	147	100

74.15% of irrigation non-adopters owned land for irrigation production on their own, and 25.85% of them got it from their family (Figure 3). Among irrigation adopters, 66.67% use their own land, and 25.17% of them use their family's land for vegetable and fruit

production. The rest, 8.16%, rent land for vegetable and fruit production by irrigation (Figure 4). Landholding size in subsistence agriculture plays a significant role in the household food security situation. According to FAO (2009), the amount of agricultural land has an impact on family food security. Most irrigation adopters (74.8%) and 100% of irrigation non-adopters owned plot sizes of less than one hectare, while only 25.2% of irrigation adopters owned pilot sizes greater than one hectare (Table 2). This finding is in line with a study conducted in the Sidama zone, Southern Ethiopia, conducted by Tizita Damtew (2017), which revealed that the average mean landholding in the study area was 0.91 hectares (ha).

Table 6: Frequency of vegetable production by irrigation users and non-users

How many times you produce annually?	Irrigation adopters and non-adopters		Total
	Adopters	Non adopters	
One time	4	147	151
Two times	143	0	143
Total	147	147	294
Pearson chi(2)= 290.0270 Pr=0.000			

Compared to non-adopters, adopters produce two times a year. Which shows their production is only based on irrigation, and rain. It is significant at 1%.

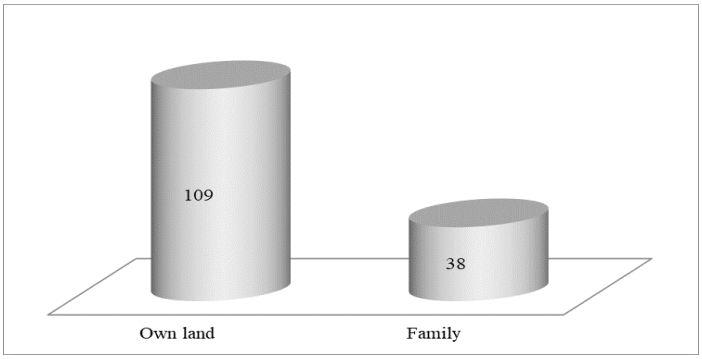

Figure 3: ownership of land for irrigation non-adopters

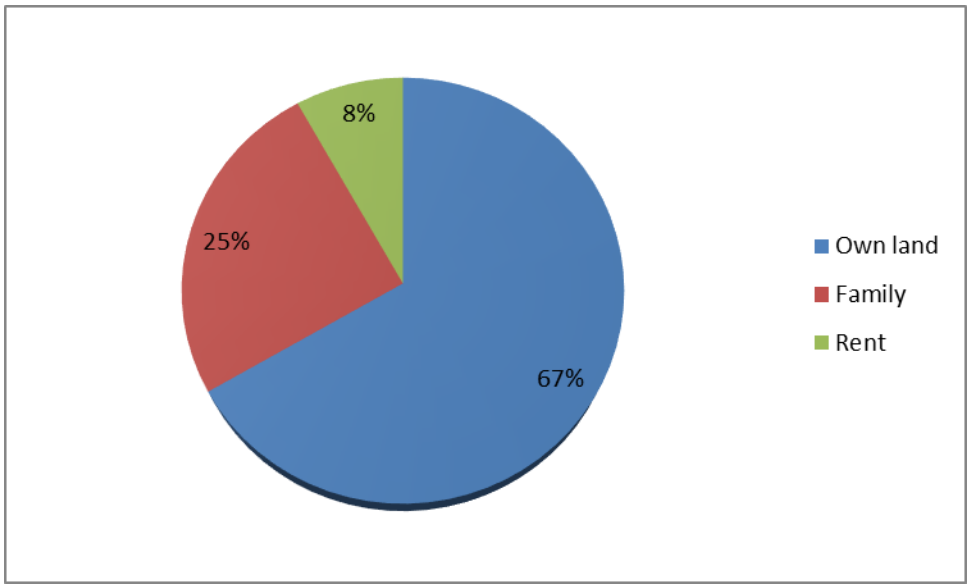

Figure 4: Land ownership for irrigation adopters

Table 7: Association of land ownership and irrigation adoption

Ownership of land	Adopter/non-adopter		Total	
	Non-adopters	adopters		
Rent	-	11.76	11.76	
Own	109	98.49	207.49	
Family	38	36.75	74.75	
Total	147	147	294	
Pearson chi2=12.5979		Pr=0.002		

There is a 5% level of significant ownership of farm land. Most farmers own farm land, but there is more adoption.

Accessibility of water for irrigation

All irrigation non-adopters had no access to water except rainwater. This means, even if underground water was available, there was less intension among vegetable non-adopters to dig and use water for irrigation, but all irrigation adopters had access to water for irrigation. 96.8% of irrigation adopter households responded that the distance from the main water source to their area of production was 1–50 meters, and 3.2% of them were more than 51 meters. This finding differs from a study conducted in the Sidama Zone, Southern Ethiopia by Tizita (2017) which indicated that of the total irrigation user respondents, 54% had gotten irrigation water from rivers while 33% of respondents had gotten irrigation water from springs. 13% of respondents had used their irrigation water from ponds.

Table 8: Distance from main sources of water

What is the approximate distance of the main water source from the center of the plot? in m	Categories of respondents		Frequency	Percent
	Non-adopters	Missing System	147	100.0
	Adopters	1-50 meters	137	96.8
		51 and more meters	10	3.2
		Total	147	100

The results obtained from the survey data showed that all irrigation adopters produce vegetables and fruits mostly for income generation, and those non-adopters also produce crops for both consumption and as sources of income. All irrigation non-adopters use mainly rainwater as a source of water, and they experienced crop loss. This failure of products was not experienced by irrigation non-adopters (Table 4). The consequences of

product failure due to lack of rain or climate variability are shortages of food for non-adopter households.

Table 9: The purpose of production and the condition of production failure

	Categories	Response	Frequency	Percent
Purpose of working production	**Irrigation adopters**	Source of income	147	100
	Irrigation non-adopters	Source of income	147	100.0
Did you experience crop failure?	**Irrigation adopters**	No	147	100
		Yes	0	0
	Irrigation non-adopters	No	0	0
		Yes	147	100
Consequences of crop failure	**Irrigation adopters**	Missing	147	100
	Irrigation non-adopters	Shortage of food	147	100

All respondents (adopters and non-adopters) thought that the agricultural extension services were adequate to provide access and enough food. Irrigation adopters produce twice annually by using irrigation. According to information from FGD, survey data showed that all irrigation adopters produce two times annually, but this result contradicts a study conducted by Daniel (2020), which states that, in contrast to agriculture, the irrigation sector in Ethiopia is underserved by extension services. Most often, irrigation is done without adequate know-how, which results in undesirable consequences such as soil salinity, groundwater rise, waterlogging, and the degradation of soil fertility.

Table 10: Agricultural extension service and frequency of production

	Categories of respondents	Responses	Frequency	Percent
Do you think that the extension services are adequate to enable you to produce and access enough food for your family?	Irrigation Adopters	Yes	147	100
		Valic Total	0 147	0 100
	Non-adopters	Yes	147	100
		No	0	0
		Total	147	100
How many times do you produce per year using irrigation?	Irrigation adopters	Two times	147	100
		Three times	0	0
	Non-adopters	Miss	147	100

4.3. Constraints of Irrigation Adoption

Under constraints of irrigation adoption, market information, agricultural input accessibility, fear of market failure, accessibility of credit, and distance from main water sources were discussed. From a key informant interview, the following idea was forwarded by one of them:

> *"... The tradition of renting property was one of the barriers to implementing irrigation." Farmers who rented their property were less likely to use irrigation. The market system around producers is also hindered by brokers and farmers (non-adopters fear market familiarity and invest in irrigation. "*

Market and Information Accessibility

The current results revealed that 54.4% of irrigation adopters said they got market information about prices of agricultural inputs and outputs, but 45.6% of them had no sufficient information. All irrigation non-adopters thought that they got market information. Regarding sources of information, most irrigation adopters (97.3%) got information from their mobile phones and the rest (2.7%) received information from television. Among irrigation none- adopters, 68.7% got information from mobile phones, 17.7% from radio and 13.6% got it from other sources. This result is in line with a study conducted by Getachew Ahmed and Tigabu Degu (2019). It indicated that common channels through which farmers get access to agricultural information include farm advice by extension advisory services, broadcasts through the media, discussions in community meetings and visits to demonstration plots. Apart from local and national mass media where general topics of adoption techniques are discussed, agricultural extension workers are the core players in all other three means of transferring agricultural information (i.e. providing on-farm advice, encouraging farmers to visit demonstration plots, and organizing community meetings). All respondents from irrigation adopters and non-adopters sell their products to the district market (Table 6). As a result, irrigators have been unable to invest in improved agricultural inputs and technology due to a lack of financing methods and market access (Daniel, 2020). High-yielding cultivars, new types of fertilizers, contemporary agricultural technology and techniques for land and water management, and new market engagement tactics are examples of such developments (Yohannes et al., 2017). While extension services are necessary to help farmers adapt and implement improved practices, access to credit and the market provide financial capacity and thereby enable farmers to invest in improved agricultural inputs and technologies. According to data obtained from FGD and KII, the price of inputs, mainly pesticides and improved varieties, has been inflating and becoming unaffordable for many farmers. These agricultural inputs sometimes become impossible to obtain from local dealers.

Fear of Market Failure

According to information obtained from FGD and key informant interviews, some farmers feared investing their money in irrigation because they thought there would be a fluctuation in the market price of vegetables and fruits since they were perishable products even though they had land accessible for irrigation. There was no agricultural insurance that enabled farmers to be insured for crop loss and market failure.

Table 11: Market information

	Categories	Responses	Frequency	Percent
Did you get market information about the prices and condition of agricultural inputs and outputs?	Irrigation adopters	Yes	80	54.4
		No	67	45.6
		Total	147	100
	Irrigation non-adopters	Yes	147	100
		No	0	0
		Total	147	100
What are the sources of information?	Irrigation adopters	Television	40	2.7
		Radio	0	0
		Mobile	143	97.3
		Others	147	100
	Non-adopters	Radio	26	17.7
		Mobile	101	68.7
		Others	20	13.6
Where did you sell your product?	Adopters	District Market	147	100
	Non-adopters	District Market	147	100

Accessibility of Credit

Credit, in particular, plays a pivotal role in the drive to transform smallholder agriculture from a subsistence level to commercial and market-oriented farming. Agriculture

generally relies heavily on credit more than any other sector because of the seasonal variations in farm income and a changing trend towards commercial and mechanized farming (Mahmood et al., 2009). From the survey data, all irrigation non-adopters never got credit and only 5.4% of irrigation adopters received credit, but 94.6% of them never received credit (table 7).

From a key informant interview, the following idea was forwarded on credit accessibility as follows

> "*... Microfinance and cooperatives exist in our area, however they only lend a little amount of money. (Less than 10,000 Ethiopian birrs), which is insufficient. It isn't enough to begin irrigation adoption to buy inputs like fertilizers, pesticides, and varieties. "*

Table 12: Credit accessibility

	Categories of respondents	Responses	Frequency	Percent
Had you receive any credit in the past one year?	Irrigation adopters	Yes	147	100
		No	00	0
		Total	147	100
	Irrigation non-adopters	Yes	00	0
		No	147	100
		Total	147	100
Do you think that the credit received was enough?	Irrigation adopters	Yes	8	5.4
		No	139	94.6
		Total	147	100
	Irrigation non-adopters	Yes	-	-
		No	-	-
		Missing	147	100

Table 13: Determinants of food security

Independent Var(V1)	Dependent Var(v2)	Notes Titles
VARIABLES	IRRUSER	Standard errors in parentheses
		*** p<0.01, ** p<0.05, * p<0.1
MARKETINFO	0.601***	
	-0.191	
ADUCEXTNSERV	0.0876	
	-0.191	
LNDOWNFRTVEG	0.492**	
	-0.243	
PLOTSIZE	-0.00505	
	-0.0872	
HHINCOM	-3.98E-06	
	-5.38E-06	
Occupation	1.526***	
	-0.577	
Education	-0.654***	
	-0.121	
Religion	0.648**	
	-0.278	
No of children	-0.414***	
	-0.125	
Sex	0.806***	
	-0.199	
Marital status	0.225*	
	-0.118	
Constant	-1.295	
	-0.94	
Observations	294	

	(1)
VARIABLES	IRRUSER
MARKETINFO	0.601***
	(0.191)
ADUCEXTNSERV	0.0876
	(0.191)
LNDOWNFRTVEG	0.492**
	(0.243)
PLOTSIZE	-0.00505
	(0.0872)
HHINCOM	-3.98e-06
	(5.38e-06)
Occupation	1.526***
	(0.577)
Education	-0.654***
	(0.121)
Religion	0.648**
	(0.278)
No of children	-0.414***
	(0.125)
Sex	0.806***
	(0.199)
Marital status	0.225*
	(0.118)
Constant	-1.295
	(0.940)
Observations	294

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

The first significant variable is market information (MARKET INFO): this variable is significant at a 1% significant level. And it is positively correlated with the use of irrigation, which contributes to food security. When a person gets additional market information, the probability of using irrigation to produce farm output will increase by 60%. Land ownership (LNDOWNFRTVEG): this variable is significant at a 5% significant level and is positively correlated with irrigation use. Relative to those who do not have land, the probability of landowners using irrigation and being food secure is greater by 24%. Type of occupation (OCCUPATION): the variable is significant at a 1% significant level. When we see this, relative to non-farm households, those farm houses' probability of using irrigation and being food secured is greater by 57.7%, and it is positively correlated. Education level (EDUCATION): this variable is instantly negatively correlated with irrigation, and it is significant at a 1% significant level. This negative correlation with the use of irrigation may be due to most educated households resembling non-farm activities like government employees and other off-farm activities. The religion of the household head (RELIGION):-This variable is also negatively correlated with the dependent variable and is significant at a five-person significant level. This negative correlation may show that some religions, like Orthodox, restrict working days due to religious holidays, reducing working days relative to other religions that do not have many holidays. Several children (NOOFCHILDREN): Those farmers who have a higher number of children who are not at working age may reduce the use of irrigation and reduce the probability of being food secure. In this research, the variable is significant at a 1% significant level. Compared to those who owned a limited number of children, those with a higher number of children used irrigation and were food secured by 41.4%. Gender of household head (SEX): This variable is positively correlated with the use of irrigation. And it is significant at a 1% significant level. When we discuss this, relative to female-headed households, the male-headed households' probability of using irrigation and being food secure is higher by 80.6%. Marital Status (MARITAL STATUS): this variable is significant at 10% and is positively correlated with the use of irrigation and food security. This may be related to labor contributions. Being single makes it challenging to accomplish several tasks compared to being paired.

4.4. Food security status of households

HFIAS was used in this study to distinguish between small-scale Irrigation adopter and non-adopter respondents' status of food insecurity (taking into consideration one component of food security: access). It has 9 generic questions and each of the questions asked has a recall period of four weeks (30 days). The reply initially asked if the condition in the question had occurred in the last four weeks, and if so, how often (yes or no). In cases when a responder replies "yes" to an occurrence question, he or she is asked how often the condition has occurred in the last four weeks (Coates, Swindale, and Bilinsky, 2007). But if the respondent said no to the first question, there was no need to go to the second. First, the date should be coded frequency-asked-questions as 0 for all cases where the answer to the corresponding occurrence question was no, and then the score is calculated for each individual by summing up the codes for each frequency-of-occurrence question. If the individual response to all nine frequency-of-occurrence questions was "sometimes," the code would be 2. As a result, a maximum score of 27 is possible, and a minimum score of 0. Therefore, the higher the score, the more food insecure (access) the individual is. Individuals who scored lower on this scale reported fewer instances of food insecurity (access to food).

The current study (table 14b) indicated that 70.7% of small-scale irrigation adopter (vegetable producer) households were food secure, 16.3% of them were mildly food insecure, while 7.5% and 5.44% of them were moderately and severely food insecure respectively. 34% of irrigation non-adopters respondents were food secure and 25.1% of them were mildly food insecure. Another 25.1% of irrigation non-adopters were moderately food insecure and the rest, 15.6% of irrigation non-adopter households were severely food insecure because they were cutting back on meal size or the number of meals. The food insecurity status of irrigation adopters in the current study is in line with but greater to some extent than in the study conducted in which (15%) are food secure, (18.5%) are food insecure without hunger, (31.7%) are food insecure with moderate hunger and (34.8%) are food insecure with severe hunger (Girma Zewdie,2019). The study was conducted in the Sidama Zone, in Southern Ethiopia. Which indicated the majority (82%) of irrigation user households were food secure. As a result, they enhance

access to food for rural residents (Weinberger and Lumpkin, 2007). As a result, vegetable producers were more food secure than vegetable non-producers. This difference comes from the purchasing power of vegetable non-producers being less than vegetable producers. According to data obtained through a survey among irrigation non-adopters, 91.8% of them only get 500-1000 birr per month, while 8.2% of them get 1001 to 2000 birr per month. The monthly income of irrigation adopters lies between 3001-4000 Ethiopian birr. This lower income of households leads to less purchasing power. From the pillars of food security, accessibility is affected. Available food should be made accessible to consumers at all times by the right holders (Yeshewas, 2019). This also means that the food in the country should be affordable and economically accessible to the community.

Table 14a: HFIAS in the past four weeks

HFIAS		Occurrence		Frequency		
		Yes	No	Rarely (1)	Some times (2)	Often (3)
1. In the past four weeks, did you worry that your household would not have enough food?	**AD**	**87**	**60**	**44**	**43**	**-**
	NA	**121**	**26**	**34**	**56**	**31**
2. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	**AD**	**39**	**108**	**22**	**16**	**-**
	NA	**84**	**63**	**57**	**27**	
3. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	**AD**	**38**	**110**	**28**	**9**	
	NA	**99**	**48**	**62**	**37**	**-**
4. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	**AD**	**38**	**109**	**27**	**11**	
	NA	**99**	**48**	**63**	**36**	
5. In the past four weeks, did						

you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	**AD**	**37**	**110**	**27**	**9**	
	NA	**63**	**4**	**38**	**25**	-
6. In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	**AD**	**38**	**109**	**27**	**11**	-
	NA	**64**		**37**	**27**	-
7. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	**AD**	**136**	**1**	**11**	-	-
	NA	**25**	**132**	**14**	**11**	-
8. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	**AD**		**147**	-	-	-
	NA	**132**	**5**	**28**	-	-
9. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	**AD**		**147**	-	-	-
	NA		**147**	-	-	-

[1] AD, Irrigation adopters[2] NA, Irrigation non-adopters

Table 14b.HFIAS prevalence of food insecurity in the study area 2021

Category	**AD**	**NA**	**Total**
Food secure	**104**	**50**	**154**
Mildly food insecure	**24**	**37**	**61**
Moderately food insecure	**11**	**37**	**48**
Severely food insecure	**8**	**23**	**31**

[1] AD, Irrigation adopters[2] NA, Irrigation non-adopters

Results from table 14b shows that there is an association between food security prevalence and monthly income, frequency of production and pilot size.

Table 14c: Association of food security prevalence, monthly income, frequency of production and pilot size.

Category	Frequency	Food security status Mildly food insecure Moderately food insecure Severely food secure				Chi-square test	Significance test
		Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure		
500-1000	135	38	37	37	23	16.32	0.000
1001-2000	12	12	0	0	0	17.43	0.000
3000-4000	294	104	24	11	8	12.53	0.000
One	151	53	25	37	23	15.25	0.004
Two	143	104	24	11	8		0.004
		129	54	45	29		0.002
≥ 1ha		25	7	3	2		0.002

CHAPTER FIVE

5. SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Summary of findings and Conclusion

The results showed that 97.3% of irrigation adopters produced annually two times and all non-adopters said they only once annually. From irrigation adopters, 2.7% are produced annually (Table 2). According to data from table 2, irrigation adopters produce mainly fruits and vegetables twice annually also crop using rainy season, while all irrigation non-adopters produce crops. The main sources of water were the lake (18.4%) and ground water (81.6%) for irrigation adopters, and all irrigation uses rain as a source of water. All irrigation non-adopters had a plot size of less than 1ha, and 25.2% of irrigation adopters owned a plot size greater than 1ha, and 74.8% of them had a less than 1ha plot size.

The current results revealed that 54.4% of irrigation adopters said they got market information about prices of agricultural inputs and outputs, but 45.6% of them had no sufficient information. All irrigation non-adopters thought that they got market information. Regarding sources of information, most irrigation adopters (97.3%) got information from their mobile phones and the rest (2.7%) received information from television. Among irrigation adopters, 68.7% got information from mobile phones, 17.7% from radio and 13.6% got it from other sources. This result is in line with a study conducted by Getachew Ahmed and Tigabu Degu (2019) which indicated that common channels through which farmers get access to agricultural information include farm advice by extension advisory services, broadcasts through the media, discussions in community meetings and visits to demonstration plots. Farmers' ability to invest in new farm inputs and technology has also been impacted by the absence of adequate finance channels and market access (Daniel, 2020).According to data obtained from FGD and KII, the price of inputs, mainly pesticides and improved varieties, has been inflating and becoming unaffordable for many farmers. Some farmers feared investing their money in irrigation because they thought there would be a fluctuation in the market price of vegetables and fruits since they were perishable products even though they had land

accessible for irrigation. There was no agricultural insurance that enabled farmers to be insured for crop loss and market failure.

The current study (table 11) indicated that 70.7% of vegetable producer households were food secure, 16.3% of them were mildly food insecure, while 7.5% and 5.44% of them were moderately and severely food insecure respectively. 34.1% of irrigation non-adopters respondents were food secure and 25.2% of them were mildly food insecure. Another 25.2% of irrigation non-adopters were moderately food insecure and the rest, 15.6% of irrigation non-adopter households were severely food insecure because they were cutting back on meal size or number of meals. The food insecurity status of irrigation adopters in the current study is in line with but greater in some extent than the study conducted in (15%) are food secure, (18.5%) are food insecure without hunger, (31.7%) are food insecure with moderate hunger and (34.8%) are food insecure with severe hunger (Girma Zewdie,2019). A study conducted in the Sidama Zone, Southern Ethiopia indicated the majority (82%) of irrigation user households were food secure. According to data obtained through a survey among irrigation non-adopters, 91.8% of them only get 500-1000 birr per month, while 8.2% of them get 1001 to 2000 birr per month. The monthly income of irrigation adopters lies between 3001-4000 Ethiopian birr. This lower income of households leads to less purchasing power. From the pillars of food security, accessibility is affected. Food which is available should be made accessible to consumers at all times by the right holders (Yeshewas, 2019).

5.2. Recommendations

Depending on the findings of the current study, the following recommendations were made:

- Responsible parties must raise awareness in order to increase the number of families who utilize small-scale irrigation.
- To reduce the influence of brokers, the agricultural sector and the woreda of trade office should improve the supply and value chain of products generated by irrigation adopters.
- Agricultural inputs (pesticides, fertilizers, and improved varieties) must be made more affordable by cooperating with the woreda of agriculture's pesticide and fertilizer registration and control, as well as the department of variety release.
- Dugda woreda Agricultural office increase their support for farmers on technical small-scale irrigation adoption issues in order to increase the number of farmers engaged in small-scale irrigation in order to reduce food insecurity households through increased production.

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Yohannes, F.; Ritsema, J.; Solomon, H.; Froebrich, J.; van Dam, C. Irrigation water management: Farmers' practices, perceptions

Appendix

Questionnaire for Respondents

Dear valued respondent

I appreciate you taking the time to share your knowledge and time with me. I really appreciate it. I am pursuing my MSc program at the Center for Food Security Studies at Addis Ababa University. My research is entitled. The Role of Small Scale Irrigation in Household Food Security in DugdaWoreda East Showa Zone, Oromia Regional State of Ethiopia.

My research encompasses an extensive analysis of the role of small-scale irrigation in household food security in the DugdaWoreda East Showa Zone, Oromia Regional State of Ethiopia. Your participation in this poll has been requested by a third party. Because I believe that you can give me ideas, information, and views on issues related to irrigation practice, the food security status of your area, and the role of irrigation in enhancing food security. Your kind cooperation in giving me and/or my research assistants an interview is highly appreciated. I want to assure you that the information you give me will be completely confidential and will be used exclusively for our study. Your replies will remain anonymous since I will not record your name.

Yohannes Bekele

Address;

Email: **joebekele0350@gmail.com**

Mobile phone: +251912610676

Addis Ababa

I. Socio-economic and demographic status of irrigation producers and non-producers

Variables	Category	Adopters No. (%)	Non-adopters No. (%)
Age group (mother)	20-30		
	31-40		
	41-50		
	Total		
Marital status	Married		
	Divorced		
	Widowed		
	Widower		
Number of children per household	Two		
	Three		
	Four		
	Five		
	Six		
	>Six		
Age of child	0-6 months		
	7 to 24 months		
	5-10 years		
	10-18 years		
Religion	Muslim		
	Orthodox		
	Protestant		
	Wakefata		
	Other		
	Total		
Education (father)	Can't read and write		

	Read and write		
	Grades 1-5		
	Grades 6-8		
	Grades 9-12		
	College		
Education(mother)	Can't read and write		
	Read and write		
	Grades 1-5		
	Grades 6-8		
	Grades 9-12		
	College		
Occupation	Housewife		
	Farmer		
	Gov't employee		
	Merchant		
	Daily laborer		
Monthly household income (ETB)	500-1000		
	1001-2000		
	2001-3000		
	3001-4000		
	>4000		

II. Level of adoption of small-scale irrigation in the study areas.

Crops, vegetables, and fruits production

1. How many times do you produce annually?
   A. One B. Two times C. three times
2. What are the main productions you produce?
   A. Vegetables and fruits B. Crops C. Spices D. other
3. Plot size and the amount produced
   A. < 1ha B. 1-2ha C. 3-4ha D. 5ha and>5ha
4. Source of water for your production plot.
   A. Rain B. lake C. groundwater D. other
5. Ownership of land for vegetable production.
   A. rent B. your own c. Family D. other
6. Purpose in working production (supplement family nutrition; source of income).
7. Did you experience crop failure due to a shortage of rainfall? a) Yes b) No
8. . If your response is 'yes' to question no 7, please mention the main rainfall shortage years? _____
9. What was/were the consequence/s?(multiple responsible is possible) a) Shortage of food b) Lack of pasture c) Shortage of drinking water d) Others, specify
10. Do your household access to water for irrigation? a) Yes b) No
11. If your response is 'no' to question no 10, what are the main reasons? a) Lack of water source b) Lack of interest c) Lack of technical skill d) Others, specify
12. . Do you think that the extension services are adequate to enable you to produce and access enough food for your family? a) Yes b) No
13. . If your response is 'no' to question no 12, what you recommend to be included or improved? ----------

No	Obstacles/ constraints	Low	Moderate	High
1	Pests and diseases			
2	Drought			
3	Erratic rainfall			
4	Insufficient farmland holdings			
5	Lack of access to appropriate technology			
6	Inability to apply sufficient modern farm inputs			
7	Shortage of cash income			

Irrigation capacity

1. Does any household members has irrigable land? a. Yes b. No
2. If yes, what is the size of the irrigable land_____?

   (In tsimad)?
3. When did you own this irrigable land? a. Before1year b. Before 2 years

   c. before3 years d. Other_____
4. How many times do you produce per year using irrigation?

   _____
5. What is the source of water for your irrigation? a. Rivers b. springs

   c. Ponds d. Wells e. Other_____
6. What is the approximate distance of main water source from center of

   Plot? _____ (in km).

Please fill the activities you did in the last one year in the following table given bellow.

No	Activity	Yes	No	Amount	Unit	Source	Values(Birr)
1	Did you use any manure from your herd on your field?						
2	Did you purchase any fertilizer for use on your field?						
3	Did you use chemicals to kill pests if you had a problem?						
4	Did you purchase improved seeds for use on your field?						
	Total						

6. Agricultural products got from irrigable land in the last one year

Crop type(see codes)	Yield (kg)	Value (Birr)	For own consumption (kg)	Value (Birr)	For sale (kg)	Value (Birr)	To other as payment for rent or gift(kg)	Value (Birr)	Total Value (Birr)

III. Determinant factors of the households for the adoption of small scale irrigation agriculture

Market information

- Did you get market information about prices and conditions of agricultural inputs and out puts? a. Yes b. No
- If yes, what is the source information? a. Radio b. Television c. Newspaper d. Mobile e. Others_____
- Where did you sell your product? a. At village market b. At district market c. At regional market d. At national market e. Others (specify) _____
- What is the distance of your residence from the market _____ (in Km)?
- What means of transport do you use to transport your product to the market? a. vehicles b. Animal labor c. Human labor d. Others (specify)_____
- When did you sell most part of your produce? _____ (months)
- Did you get fair price for your produce at this particular time? a. Yes 2. No
- If no, what are the reasons? a. No demand b. More supply c. Others (specify) _____
- Why did you sell at that particular time? a. To appropriate family requirements b. To pay debts c. Other_____

Credit system

Had you receive any credit in the past one year? a. Yes b. No

If yes, for what reason (s)? a. Purchase of seeds b. Purchase of fertilizer c. purchase of oxen d. for family consumption e. Others(specify)_____

When do you usually take the credit? _____ (months)

What are the Sources of credit? a. Service cooperative b. Commercial banks c. Friends d. Other_____

If no why? a. Lack of access to credit b. No need for credit c. High interest rate d. Other_____

Did you face food shortage during last one year? a. Yes b. No

If yes, during which months? _____

What do you think the main causes of food deficit in your particular area? a. Variability in rainfall b. Incidence of pest, diseases, weeds etc. c. Lack of access to credit d. Lack of appropriate extension support e. other_____

IV.HFIAS in the past four weeks in households of vegetable producers and non-producers

HFIAS	Location	Occurrence		Frequency		
		Yes	No	Rarely (1)	Some times (2)	Often (3)
1. In the past four weeks, did you worry that your household would not have enough food?	Producer					
	Non-producer					
2. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Producer					
	Non-producer					
3. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	Producer					
	Non-producer					
4. In the past four weeks, did you or any household member have to eat some foods that you did not want to eat because of a lack of resources to obtain other types of food?	Producer					
	Non-producer					
5. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Producer					
	Non-producer					
6. In the past four weeks, did you or any other household member have to	Producer					
	Non-producer					

eat fewer meals in a day because there was not enough food?						
7. In the past four weeks, was there ever no food to eat of any kind in your household because of a lack of resources to get food?	Producer					
	Non-producer					
8. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	Producer					
	Non-producer					
9. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	Producer					
	Non-producer					

□Rarely, (once or twice in the past four weeks;

□Sometimes, three to ten times in the past four weeks;

□Often, more than ten times in the past four weeks

□Did you face food shortage during last one year? a. Yes b. No

Thank you