SCHOOL OF GRADUATE STUDIES

FACTORS AFFECTING USE OF SMALL-SCALE IRRIGATION ON HOUSEHOLD LEVEL IN THE AFAR REGIONAL STATE AMIBERA WOREDA: IN CASE OF MELKA WERER KEBELE

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ADDIS ABEBA, ETHIOPIA

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A THESIS SUBMITTED TO SAINT MARY'S UNIVERSITY SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE DEGREE OF MATER'S OF ARTS IN DEVELOPMENT ECONOMICS

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DECLARATION

I, Nuhamin Kumlachew, hereby declare that this Thesis work titled "Factors Affecting Use of Small-Scale Irrigation on Household Level in the Afar Regional State Amibera Woreda: in case of Melka Werer Kebele" is my original work; any assistance I received in the preparation of this thesis is fully acknowledged and disclosed. I have also cited any sources from which I used data, ideas or words, either quoted directly or paraphrased.

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ENDORSEMENT

The thesis prepared, under my guidance, by Nuhamin Kumlachew Dawit, tiltled "Factors Affecting Use of Small-Scale Irrigation on Household Level in the Afar Regional State Amibera Woreda: in case of Melka Werer Kebele" has been submitted to St. Mary's University, School Of Graduate Studies for examination with my approval as the university advisor.

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APPROVAL OF BOARD OF EXAMINERS

As a member of the Board of Examiners of the Master's Thesis Open Defense Examination, we certify that we have read and evaluated the Thesis prepared by Nuhamin Kumlachew Dawit under the title of "Factors Affecting Use of Small-Scale Irrigation on Household Level in the Afar Regional State Amibera Woreda: in case of Melka Werer Kebele". We recommend the thesis to be accepted as fulfilling requirement for the Degree of Master of Art in Development Economics.

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DEDICATION

This Thesis work is dedicated to my beloved family, whose support and encouragement had given me strength to be who I am and to reach where I am right now. I'm really thankful for having you all. You are the best, and you deserve more.

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ACRONYMS AND ABBREVIATIONS

ACC: Agricultural Commercialization Clusters

ADLI: Agricultural Development Led Industrialization

ATA: Agricultural Transformation Agency

AWMP: Agricultural Water Management Project

CIA: Conditional Independency Assumption

FAO: Food and Agricultural Organization

FANTA: Food and Nutrition Technical Assistance

FDRE: Federal Democratic Republic of Ethiopia

FGD: Focus Group Discussion

FCS: Food Consumption Score

GDP: Gross Domestic Product

HDD: Household Dietary Diversity

HFIAS: Household Food Insecurity Access Scale

IFPRI: International Food Policy Research Institutes

IWMI: International Water Management Institute

LIVES: Livestock and Irrigation Value Chain for Ethiopian Smallholder

MoA: Ministry of Agriculture

MoARD: Ministry of Agriculture and Rural Development

MoFED: Ministry of Finance and Economic Development

MoWIE: Ministry of Water, Irrigation and Electricity

PSNP: Productive Safety Net Program

SDGs: Sustainable Development Goals

SNNPRS: South Nation, Nationalities and Peoples Region State

SPSS: Statistical Package for Social Sciences

TLU: Total Livestock Unit

UNECA: United Nations Economic Commission for Africa

WFS: World Food Summit

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ABSTRACT

Irrigation as an agricultural intensification plays significant role in increasing agricultural production and harvest. This study scrutinized the factors influencing the use of small-scale irrigation at the household level. In this study multi-stage sampling techniques were used to select 150 target respondents in which 90 irrigation users and 60 non-irrigation user. The determined sample size of the study was 376 households (226 non-irrigation users, which are the control group and 150 irrigation users, which are the treated group) were selected to participate in the study. The researcher used both quantitative and qualitative data collected through a questionnaire. To analyze the data descriptive analysis and propensity score matching were used to evaluate the effect of irrigation on household food security. They found that factors such as family size, education level of the household head, access to extension services, and access to fertilizer positively influenced the adoption of small-scale irrigation. Livestock holding, number of dependents, and age of the household head had a negative relationship with irrigation use. Overall the study finding indicates that small scale irrigation practices in the study area have made marks on the economic development of the participants.

Therefore, supporting and encouraging the use of small scale irrigation, strengthening the extension services, and encouraging farmers engaged in small scale irrigation is recommended.

Key words*: small scale Irrigation, Food security, Households, Irrigation users, and non-user*

CHAPTER ONE

1. INTRODUCTION

1.2. Background of study

Around the world, over 307 million hectares were prepared for the water system, of which 304 million hectares were for the full control water system and 261 million hectares were equipped for full control and irrigated (Jambo et al. Agric & Food Secur (2021). Irrigation-based agriculture plays an essential role for global food security and for the welfare of a large share of the world's population, as it provides about 40% of the global crop production.

Agriculture contributes substantially to the economic growth of many low-income countries especially sub-Saharan countries.

Because Ethiopia is an agricultural country, farming is the leading sector as a source of income, employment, and foreign exchange, and public profitable growth is determined by the performance of husbandry (Getaneh, 2015).

Agrarian irrigation growth is pivotal to perfecting smallholder livelihood and income in Ethiopia since irrigation can help cultivators increase their crop product, increase crop variety, and outstretch their agrarian seasons (Sesen, 2013). The emergence and spread of Irrigation support successful crop growing stabilize crop yields and increase the income of agriculturists. In other words, Irrigation increases agrarian productivity and ranch income per hectare (Abraham etal., 2015). Ethiopia has set itself an ambitious task to achieve an irrigation target of1.8 million hectares for irrigation development. The challenges include, amongst others, closing the gap between the planning and perpetration of irrigation systems, perfecting the performance of being irrigation schemes, removing constraints on the scale- up of irrigation systems, and assuring the sustainability of water finances for irrigation (Seleshi etal., 2010).

The agrarian sector of Ethiopia is dominated by smallholder agriculture (FAO). Smallholder farms are defined as being lower than 2 ha and are substantially handled with family labor (Yihdego AG, Gebru AA 2015). In Ethiopia, about 95 of the main crops (e.g., cereals, beats, oilseeds, vegetables, root crops, fruits, and cash crops) are produced by smallholder granges (Nkhoma BG 2011). Nevertheless, these farms are facing varied constraints that hinder crop productivity. Major constraints include poor soil fertility, severe land declination, high dependence on downfall, low vacuity and poor quality of seeds and diseases, profitable constraints like low income and lack of fiscal support, as well as inadequate programs and guidelines Makombe etal., (2011).

Weather situation related to climate change like severe failure and heavy downfall also affect the agrarian sector. Some studies show that among others; age, education position, ranch experience, education position, total beast unit, and family sizes shows significant difference for actors of irrigation druggies. Seid Hussien1, Getechew Mitiku (2022).

Ethiopian husbandry substantially depends on rain fed. Either, the productivity of the sector is veritably low and delays behind the rate of population growth and incompletely strengthening food instability of the country in the last decades. Gamachu Ayala,et al. (2018). Presently, the government of agrarian policy of Ethiopia paid high attention to developing small- scale irrigation through water harvesting technology in different corners of the country to support original growers to ameliorate agrarian productivity, insure food security and reduce poverty.

The use of small- scale irrigation is important to increase productivity, household incomes, employment, use different products throughout the time, and profitable development. In Ethiopia, the average crop yield per hectare from irrigated land increases 2.3 times advanced than the yield produced by rain- fed. Advanced productivity helps to increase returns to cultivators' gifts of land and labor resources and produced further than double per time. To increase productivity and diversify the livelihood scripts as an option, the development of small-scale irrigation schemes has been introduced through water crop technology.

Small- scale irrigation is an important strategy in reducing pitfalls associated with downfall variability, product of different crops doubly or three times within a time and adding income. In trying to do so, Ethiopia has yet developed not further than 5 of the irrigation eventuality. In Ethiopia, development strategies in the last decade have largely focused on the expansion of irrigated agriculture. One of the best strategies to combat poverty and stimulate the economy is to adopt irrigation development programs. These plans increase crop production by increasing yield, acreage, and the number of cropping cycles each year while lowering the likelihood of crop failure. In order to raise food production and improve the self-sufficiency of the constantly expanding human population, irrigation availability should be increased and reliance on rain-fed agriculture should be reduced (Jaleta et al., 2013). The management of water resources in agriculture has a significant role in Ethiopia's economic and social growth.

Irrigation can only work if other agricultural system components are also effective (such as seeds and extension). Small-scale farmers have traditionally dominated agricultural activity in Ethiopia for generations, and this dominance has long been negatively impacted by rain and water shortages, which have forced many to rely on famine relief assistance to just 3 percent using irrigated agriculture (FAO, 2015).

Ethiopia ranks as the ninth most vulnerable countries in the world to natural disasters and weather-related shocks because to its significant dependence on rain-fed agriculture, other topographic and limited adaptive capacity, and other associated characteristics (Tongul and Hobson, 2013). Irrigation helps to reduce poverty by boosting productivity, which raises income and encourages economic growth and employment (Garcia-Bolanos et al., 2011).

Farmers have chances to enhance output on a sustainable basis and contribute to the security of food supplies as a result of the rapid expansion of irrigation, particularly small-scale water use (FAO, 2012). In order to boost agricultural productivity and production, Ethiopia's government has given irrigation facility building a high priority. This could aid farmers in overcoming the high cost of building modern irrigation systems as well as the issue of inadequate moisture for crop production. According to NPC (2015), the government also intends to carry out a medium- and large-scale irrigation study, as well as planning activities and preparing them for concerned important parties.

The Afar region is one of Ethiopia's poorest and least developed regional state. The federal, regional, and local governments are extremely concerned about the ongoing drought, ongoing food shortages, and famine in the Afar region. Ethiopian Federal Ministry of Agriculture (2021) also states that the region's food security status is a major worry.

Arid and semi-arid climatic conditions with irregular and low rainfall patterns are present in the Amibera Wereda, which is part of the Afar area (Ayenew et al., 2021). A lack of rain has a negative impact on agricultural output, which results in failed crops, lower yields, and restricted access to food sources for the local population.

Food insecurity is further made worse by the area's reliance on conventional, low-intensity irrigation techniques. Limited access to modern irrigation technologies and water management systems hinders the effective utilization of available water resources for agricultural purposes (Nigatu, 2018). Inadequate irrigation habits, including inefficient water use, lack of proper irrigation infrastructure, and limited knowledge of irrigation techniques, further contribute to low crop productivity and food scarcity.

The combination of low rainfall and inadequate irrigation practices in the Amibera Woreda has a severe impact on the livelihoods of the local population, resulting in recurring food crises and high levels of food insecurity. Insufficient food production exacerbates the vulnerability of communities, leading to malnutrition, poverty, and a cycle of dependency on external assistance.

Addressing food insecurity in the region requires comprehensive strategies that focus on improving both rainfall resilience and irrigation practices. Implementing climate-smart agricultural techniques, such as water harvesting, efficient irrigation methods, and the adoption of drought-tolerant crop varieties, can help mitigate the adverse effects of low rainfall (Ayenew et al., 2021).

As result the researcher was initiated or inspired to study the factors affecting small scale irrigation of the study area.

1.2. Statement of the Problem

In times of low rainfall, the use of small-scale irrigation is crucial for increasing output. Irrigated agriculture is currently a top priority in the Ethiopian government's agricultural transformation and food security policy (Abdissa F, Tesema G, Yirga C 2017). The Ethiopian government had made an enormous investment to advance small-scale irrigation schemes, and strategies to increase the level of irrigation infrastructure three fold until the end of 2020 to solve the household food insecurity problem of smallholder farmers (Haile and Kassa 2015). Small scale irrigation is prioritized as one of the best alternatives for sustainable livelihood improvement, transformation growth and rural poverty alleviation in the country (Dereje and Desale 2016).

The study by Tesfaw (2018) found challenges in irrigation development including a lack of technical knowledge in modern irrigation systems, inadequate awareness of water management and scheduling, limited knowledge of improved agronomic practices, reliance on scheme-based approaches, and insufficient involvement in project design and maintenance.

In their study, Brown et al. (2020) discovered that households' ability to use small-scale irrigation systems is hampered by a lack of financial resources and credit availability. It is difficult for households to invest in irrigation infrastructure and equipment because of high upfront costs, restricted lending options, and a lack of financial support systems. Recent research by Johnson et al. (2021) has demonstrated that farmers in the area lack basic information and understanding about small-scale irrigation strategies. The successful use of irrigation systems is hampered by a lack of technical knowledge and competence in irrigation techniques and management, which has a negative impact on productivity and water use efficiency. The absence of institutional support and policies that are supportive of small-scale irrigation was another key aspect noted by Thompson et al. (2018). Limited government involvement, inadequate extension services, and a lack of supportive regulations create unfavorable conditions for households to engage in and sustain small-scale irrigation practices.

The use of small-scale irrigation at the household level in the Afar Regional State, specifically in Melka Werer Kebele of the Amibera Woreda, is influenced by various factors. Recent research conducted by different researchers has shed light on these factors, highlighting their significance and the implications they have on the adoption and sustainability of small-scale irrigation practices.

Existing studies have mostly focused on broader irrigation practices in Ethiopia or other regions, neglecting the unique socio-economic and environmental context of Afar Regional State, Amibera wereda, and Werer kebele. Therefore, there is a need to address this research gap and provide insights into the factors influencing the use of small-scale irrigation in this particular area.

Therefore, this research aims to investigate and identify the factors affecting the use of small-scale irrigation at the household level in the Afar Regional State, Amibera wereda, focusing on Werer kebele, in order to fill the existing research gap and provide evidence-based recommendations for promoting and enhancing small-scale irrigation practices.

1.3. Objectives of the study

1.3.1 General objective

The general objective of this study is to identify factors affecting use of small scale irrigation at household level in the Afar Regional state, Amibera woreda in case of Melka werer kebele.

1.3.2 Specific Objectives

The specific objectives of the study are:

1. To identify the socio-economic characteristics of households engaging in small-scale irrigation in the study area.

2. To investigate the perceptions, attitudes, and knowledge of farmers towards small-scale irrigation in Melka werer kebele.

3. To assess the role of institutional support, including policies, programs, and extension services, in promoting small-scale irrigation in Melka werer kebele.

1.4. Research Questions

The purpose of this study is to answer the following questions:

1. What are the socio-economic characteristics of households engaging in small-scale irrigation in the study area?
2. What knowledge do farmers have about small-scale irrigation in Melka werer kebele?
3. To what extent does institutional support, including access to fertilizer and Access to extension services, promote small-scale irrigation in Melka werer kebele?

1.5 . Scope and Limitation of the Study

1. **Geographical Scope**: The study is limited to werer kebele in Amibera woreda, which may restrict the generalizability of the findings to other kebeles or regions within the Afar region or Ethiopia.
2. **Time Constraints**: The findings might reflect a specific period, potentially limiting their applicability to different temporal contexts.

3. **Sample Size**: The study's conclusions may be influenced by the available sample size of small-scale irrigation users in Meleka werer kebele. The findings may not fully represent the diverse characteristics and experiences of all households in the area.
4. **External Factors**: While the study examines factors affecting use of small-scale irrigation, it may not comprehensively account for other external factors that can influence use of small-scale irrigation.

1.6. Significance of the Study

The research on factors affecting the use of small-scale irrigation at the household level in the Afar Regional State, specifically in Amibera Woreda and Werer kebele, holds significant importance due to the following reasons:

By identifying the factors influencing irrigation use, the study aims to provide insights into strategies and interventions that promote sustainable irrigation practices, improve food availability, generate income, and reduce poverty in the area. The findings can inform policymakers, government agencies, and development organizations about the challenges and opportunities related to small-scale irrigation, guiding the formulation of effective policies and programs. Additionally, understanding these factors can contribute to improved water resource management by identifying challenges and providing recommendations for optimizing water use efficiency and mitigating environmental impacts.

The adoption of small-scale irrigation technologies and improved agronomic practices can also promote sustainable agriculture by reducing reliance on rain fed agriculture and increasing crop production. This study fills a research gap by providing context-specific insights into small-scale irrigation at the household level in the study area, allowing stakeholders to make informed decisions and design targeted interventions to benefit rural households and the agricultural sector in the Afar Regional State.

1.7. Organization of the Study

This study contains five chapters. The first chapter introduces the background; the statement of the problem, objectives of the study, research questions, scope of the study, significance of the study and Scope and Limitation of the Study. The second chapter covers literature review, concerning concepts and definition of small scale irrigation, historical development of small scale irrigation, use of small scale irrigation, types of irrigation and empirical studies.

Chapter three is about methodology, which consists of description of the study area; trends of small-scale irrigation schemes on the study area, research design, sample size, Sampling techniques and procedure, data collection techniques and data analysis. Chapter four presents the study results and discussion part of the research, and finally conclusion and recommendation are presented in chapter five.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Concepts and Basic Definition

Ethiopia has abundant water resources, but its agricultural system does not yet fully benefit from the technologies of water management and irrigation. (Eshete, D.G. et al. 2020.) Rain-fed agriculture through area expansion and intensification alone is not enough to provide the basic requirements of food, clothing and energy for the rising population. Hence, the development of irrigation will be essential to augment rain-fed agriculture.

Definition for irrigation

Irrigation is the supply of water to crops by artificial means (Martin, Derek M. Heeren, & Glenn J. Hoffman. 2021). It is designed to permit the desired plant growth in arid regions and to offset drought in semiarid regions or sub humid regions. Even in areas where average seasonal precipitation may seem ample, rains are frequently unevenly distributed, or soils have low water holding capacities so that traditional rain fed agriculture is a high-risk enterprise. Irrigation provides a means for stable food production. Water Management for Sustainable Agriculture by Eric Odada and Muthoni Mathai (2018) defines irrigation as the controlled application of water to crops or plants at regular intervals to ensure optimal growth and yield.

Definition for small scale irrigation

Small-scale irrigation refers to the practice of providing water to agricultural fields or gardens on a relatively small scale, typically using localized systems and technologies (World Bank, 2019). In order to supplement natural rainfall and promote optimal development and productivity, it involves the regulated distribution of water to crops or plants. The context, resources available, and special needs of the farmers or gardeners all influence small-scale irrigation techniques. Small-scale irrigation is described as a water-saving technique that precisely supplies water to the root zone, reducing water loss and increasing crop productivity Wandera et al. (2016)

According to a Case Study in Zimbabwe" by Enes Kaçar et al. (2019) defines small-scale irrigation as the practice of providing water to plants using localized methods such as drip irrigation or sprinklers.

2.1.1. History of Irrigation in Ethiopia

In a research to determine if irrigation played a significant role in state formation and urban development in the ancient civilization of Axum, Northern Ethiopia, Sulas et al. (2009) discovered that there was insufficient data, regardless of water management of rain-fed agriculture. However, traditional irrigation has been used for many years in Ethiopia (Bekele et al., 2012). Additionally, irrigation techniques have been used for producing food crops for sustenance in Ethiopia's highlands since ancient times (Awulachew et al., 2007; Bacha et al., 2011; MoA, 2011a). Different authors, including Awlachew et al. (2007), Makombe et al. (2007), Hagos et al. (2009), and Bacha et al. (2011), emphasized that Ethiopian smallholder farmers have used supplementary irrigation to address their livelihood issues for many years.

The use of Spate irrigation has a long history in Ethiopia (Mehari et al., 2011), especially in Southern Tigray and a few semi-arid regions in the Oromia region (MoA, 2011a). Water harvested from flush floods inundated from larger catchments at upper streams has been utilized in this irrigation scheme. These conventional irrigation systems were created and administered by establishing a water user's association, which was led by an individual, for the purposes of construction, water allocation, operation, and maintenance (Belay and Bewket, 2013). Up to 200 users can be found in this association, which is made up of 20 to 30 groups of farmers who utilize the same main canal or one of its branches (MoA, 2011).

Despite the common assertion that "irrigation was started in Ethiopia during ancient times," the precise date when irrigation began in Ethiopia has not been determined from the aforementioned talks. Awlachew et al., 2007, Makombe et al., 2007, Hagos et al., 2009, and Bacha et al., (2011) are few examples.

However, the bilateral arrangement between the Ethiopian government and the Dutch business known as HVA-Ethiopia sugar cane plantation in the early 1950s led to the beginning of modern irrigation (MoA, 2011a; Bekele et al., 2012). While groundwater use has just recently begun on a pilot basis in the East Amhara region, surface water sources still provide the majority of Ethiopia's traditional irrigated lands (MoA, 2011a).

Pressurized spray irrigation systems were once used on several private farms in the Rift Valley, Eastern Amhara, Southern Tigray, and Fincha State Farm, according to MoA (2011a). Modern irrigation in Ethiopia begins in the Rift Valley, particularly in the Awash River Basin where the use of pump irrigation starts. For the production of cotton, wheat, and commercial fruits like bananas, respectively, surface irrigation technologies namely basin irrigation and furrow irrigation were used. Meanwhile similar reports such as Haile GG, Kasa AK (2015) explained that irrigated agriculture was started in Ethiopia in the upper Awash Valley with the objective of producing industrial crops as sugarcane, cotton and horticultural crops on a large-scale basis, explained in a remarkable emergence of irrigation development and establishment of agro industrial centers.

These were accomplished by utilizing the Koka Dam, which was built to serve as a reservoir for irrigation water supply, flood control, and hydropower generating. Windmills and hand pumps were first used to extract groundwater for home, agricultural, and drinking reasons in the middle of the 1970s (MoA, 2011a).

According to Ethiopia's Ministry of Agriculture, there are contemporary water management and storage technologies for irrigation. This comprises water diversion plans, dams for storing water, small-scale irrigation systems, methods for collecting rainwater, and shallow groundwater extraction methods. To lift, carry, and apply irrigation water for use in irrigation, these systems employ several water-drawing irrigation technologies. Night water storage facilities, Treadle pumps for lifting water, smallholder drip systems and micro sprinklers for irrigation application are used among others (MoA, 2011a).

2.1.2. Irrigation Developments in Ethiopia

For Ethiopia's agriculture to flourish in a sustainable and reliable way, irrigation development is essential. In Ethiopian agriculture, irrigation can be used to boost the income of smallholder farmers who mostly cultivate for subsistence (MoA, 2011b). Similar to this, using irrigation agriculture will enable greater agricultural production to fulfill the rising food demands of the rapidly expanding population. Due to its ability to spur economic growth and rural development, irrigation development in Ethiopia can be seen as a pillar of strategies for ensuring food security and reducing poverty (Hagos et al., 2009). As a result, irrigation infrastructures are growing year after year, demonstrating the benefits of modest and large-scale irrigation systems for national development. In Ethiopia, farm size per household is 0.5ha and the irrigated land per households' ranges from 0.25 ha - 0.5 ha in the Ethiopian context (MoA, 2011). As a result, individual land holdings per households are too small to feed the household. With this limited landholdings, increasing food demands of the population depends on either one or a combination of increasing agricultural yield, increasing the area of arable land, and increasing cropping intensity by growing two or three crops per year using irrigation (MoA, 2011a).

On the other hand, Ethiopia's development of irrigation is still in its infancy (MoA, 2011a). Therefore, in an effort to significantly reduce poverty and foster social transformation, the Ethiopian government is pursuing plans and programs to develop irrigation. The average pace of irrigation development in Ethiopia over the past 12 years has therefore been between 1,090 and 1,150 ha/year (Nata et al., 2008; Bekele et al., 2012). Gebremedhin and Pedon (2002) found that just 10% of Ethiopia's estimated irrigable area is really irrigated, and MoWR (2001) found that 2% of cultivated lands are also irrigated. Similar to this, barely 3% of the nation's overall food production comes from irrigated agriculture (Bacha et al., 2011). Because of this, irrigated agriculture still has a long way to go despite significant investment, widespread backing, and government policy support.

According to Belay & Bewket (2013), irrigation water is essential for reducing poverty by boosting rural productivity and enhancing food security as well as rural livelihoods. Local governments have recently placed a lot of emphasis on smallholder irrigation to help farmers cultivate crops twice a year or more. In their study of the effects of small-scale irrigation on household poverty in central Ethiopia, Bacha et al. (2011) found that irrigators had significantly higher land productivity, asset ownership, credit utilization, extension support, resilience to poverty, mean off-farm income, and mean food consumption as well as expenditure on both food and non-food assets than non-irrigators. Irrigation development is taking place through the use of government budgets, donor programs and NGOs.

Irrigation's contribution to the national economy is only approximately 2.5% of GDP, which is quite low compared to its potential and rain-fed agricultural (G Zerssa, 2021, MoA, 2011). In addition, Ethiopia's current irrigation development is insignificant in light of its irrigation potential (MoA, 2011). Therefore, irrigation must significantly contribute to reducing poverty and mitigating food insecurity.

The most used irrigation categorization method in Ethiopia is this one. As a result, according to Makombe et al. (2011), 46% of irrigation development proposals fall under the small-scale irrigation category.

2.1.3. Use Small-scale irrigation system

Although Ethiopia's small-scale irrigation system has a number of flaws, farmers still have traditional water users associations in the form of water communities (Haile GG, Kasa AK (2015). Small-scale irrigation systems in Ethiopia typically span an area of up to 100 hectares.

In order to provide the moisture required in the plant root zone and prevent stress that could result in a decreased yield and/or poor quality of agricultural harvest, irrigation is described as the artificial application of water to soil (Reddy, 2010). This is a deliberate human action to apply water for growing crops, particularly during dry seasons when rainfall is scarce. There are several ways to apply water to crop fields. The most commonly used and most ancient type is surface irrigation methods through using gravity forces (Tesfaw M (2018). This was particularly employed along riverbanks and is independent of mechanical equipment. These water application systems include drip irrigation and sprinkler systems.

In Ethiopia, irrigation is regarded as a fundamental tool for reducing poverty and ensuring food security. The conversion of the rain-fed agricultural system, which is dependent on rainfall, into a rain-fed and irrigation-fed agricultural system, is beneficial. This is regarded as the most well-known method of sustainable development in the nation.

To genuinely understand the history of irrigation's emergence and subsequent changes, it is necessary to look into how irrigation methods have evolved in Ethiopia. Tesfaw M (2018); Abraham et al., (2011) listed out the benefits of irrigation that includes; increase food production in arid and semi-arid regions, enhances food production, promotes economic growth and sustainable development, create employment opportunities, and improve living conditions of small-scale farmers. As a result, irrigation contributes to poverty reduction and protects the environment from degradation and pollution. Furthermore, it increases subsurface water levels and recharges groundwater. As a result, small, medium and large scale irrigation infrastructure needs to be developed in the country. This helps to produce export commodities that would earn foreign exchanges and provides raw materials to the local industries. Since, most of the irrigation development in Ethiopia is expressed through an expansion of small-scale irrigations.

Medium and large scale irrigation developments are needed to be taken into consideration. However, the development of irrigation practices in Ethiopia has to be investigated so as to seriously know the history of irrigation emergence and its subsequent developments (Haile G G, Kasa AK (2015)

2.1.4. Types of Irrigation

Agriculture is the backbone of the Ethiopian economy and it contributes about 50% of the country's gross domestic product (GDP) and more than 80% of its exports. (Stellmacher, T.; Kelboro, G, 2019) Furthermore, it is one of the main employment sectors with about 80% of the country's population depending on the agricultural sector for their livelihoods [Aweke, M. Gelaw 2017]

Irrigation development is a key for suitable and reliable agricultural development which leads to overall development in Ethiopia (Belay M, Bewket W (2013) Farmers). Now day's irrigation activities to be develop by different ways like the extension workers would like to provide information to create the farmers awareness for the advantage of irrigation system, the government policy could support the system and also state farm and other investment which are using irrigation system is a role model for farmers. The three main categories based on area coverage are small-scale irrigation systems, medium-scale irrigation systems, and large-scale irrigation systems.

1. **Small-scale irrigation systems (<200 hectares (ha)):** Small-scale irrigation systems typically cover areas smaller than 200 hectares. To irrigate their agricultural fields or gardens, local communities or individual farmers frequently use these systems. They frequently make use of straightforward and inexpensive technology, such as miniaturized pumps, sprinklers, or drip irrigation systems. In places with little rainfall or unstable water sources, small-scale irrigation is essential for increasing crop productivity. (United Nations Food and Agriculture Organization, 2019). According to Dereje and Desale (2016), small scale irrigation in Ethiopia refers to smallholder farms with irrigation schemes that are typically 200 hectares or less in size. (Haile and Kassa 2015).

The modern and the traditional small-scale irrigation schemes are the two main categories. The traditional are built by the local community using local materials, whereas the modern are built by the government or NGOs and have a more permanent structure and enhanced water control systems (Mosissa and Bezabih 2017). Every year after the end of the rainy season, reconstruction is always required (Mosissa and Bezabih 2017). Both traditional and modern small scale irrigation schemes are farmer-managed irrigation systems with their own local leadership of water users' associations or irrigation cooperatives (Mosissa and Bezabih, 2017). Usually farmers have the majority controlling influence, which they can operate and maintain effectively with help of government or NGOs technical and material support (Desta and Almaz 2015).

2. **Medium-scale irrigation systems (200-3,000 ha):** Medium-scale irrigation systems cover areas ranging from 200 to 3,000 hectares. In comparison to small-scale systems, they are often larger in scale and demand more sophisticated infrastructure and management. To deliver water to the fields, these systems frequently include building canals, reservoirs, and pumping stations. Typically, government organizations, water user associations, or agricultural cooperatives oversee medium-scale irrigation systems.
3. **Large-scale irrigation systems (>3,000 ha):** Large-scale irrigation systems cover areas exceeding 3,000 hectares. These systems are typically implemented for extensive agricultural production or large-scale commercial farming. They require significant investments in infrastructure, such as large dams, extensive canal networks, and high-capacity pumping stations. Large-scale irrigation systems are usually managed by government agencies or large agricultural enterprises. El-Hage Scialabba, N., & Hattam, C. (Eds.). (2012).

2.1.5. Factors affecting the use of small-scale irrigation at the household level

Small-scale irrigation plays a crucial role in enhancing agricultural productivity and food security at the household level. However, its adoption and effective use are influenced by various factors that need to be understood to promote its sustainable implementation. This study aims to examine the factors affecting the use of small-scale irrigation at the household level and their implications for improved water management and agricultural practices.

Several studies have found a positive relationship between male-headed households and participation in irrigation. For example, a study by Kassie et al. (2018) in Ethiopia found that male-headed households were more likely to adopt irrigation technologies compared to female-headed households. Similarly, a study by Njuki et al. (2011) in Kenya found that male-headed households were more likely to engage in irrigation farming.

Sex of the Household Head: Gender dynamics can influence decision-making and resource allocation within households, including the adoption of small-scale irrigation. A study by Yirga et al. (2019) in Ethiopia found that female-headed households faced additional challenges in accessing and utilizing irrigation technologies compared to male-headed households.

Access to Fertilizer: The availability and affordability of fertilizers can affect the productivity and profitability of small-scale irrigation practices. A study by Gebremedhin et al. (2018) in Ethiopia found that limited access to fertilizers hindered the adoption and success of small-scale irrigation among farmers.

Age of household head: A study by Desiere et al. (2019) in Burkina Faso found that younger farmers were more likely to adopt modern irrigation technologies compared to older farmers. This could be due to the fact that younger farmers are generally more educated and more willing to take risks compared to their older counterparts.

Household Education Level: The education level of household members can affect their knowledge and understanding of irrigation techniques and practices. Research by Ghebremicael et al. (2018) highlighted the positive relationship between education level and the adoption of small-scale irrigation in Eritrea.

Size of Cultivated Land: The size of cultivated land can determine the need for irrigation and the feasibility of implementing small-scale irrigation systems. A study by Nhamo et al. (2019) in Zimbabwe found that households with larger cultivated land areas were more likely to adopt small-scale irrigation.

Access to Extension Service: Access to extension services, which provide technical advice and support to farmers, can play a crucial role in promoting the adoption and sustainable use of small-scale irrigation. Research by Ghebremicael et al. (2018) in Eritrea highlighted the importance of extension services in improving farmers' knowledge and skills related to irrigation.

Family Size: The size of the household can influence the labor availability and capacity for implementing and maintaining small-scale irrigation systems. Research by Ashagre et al. (2020) in Ethiopia showed that larger households tended to have more labor resources, which facilitated the adoption and management of small-scale irrigation.

2.2. Empirical Studies on Determinants of Irrigation Practices

Different studies have been conducted by different scholars on the determinants of adoption of irrigation practice by farm households in different countries of the world. The scholars found different factors that determine participation in irrigation practice by small scale farm households using different models and hypothesizing different repressors that influence irrigation practice. Therefore, this section has been concerned with review of previous empirical studies to come up with convincing information with most commonly significant variables affecting adoption of irrigation practice to use them as a basis of the hypothesis for this study.

Numerous research produced conflicting findings regarding how economic factors including wealth, the amount of arable land a farm owns or operates, and the number of household-owned oxen influence farmers' usage of small-scale irrigation. For instance, using binary logit and binary probit models, respectively, Kinfe et al. (2012) and Abebaw et al. (2015) discovered that the farmer's income had a favorable impact on the use of irrigation by smallholder farmers. They demonstrated that higher income farm households participate in irrigation practice more frequently than lower income farm households and may spend more money on irrigation than low income farm households.

On the other side, it has been discovered that land ownership has a detrimental impact on farmers' irrigation practices (Edo, 2014). However, Beyan et al. (2013) report that there was a favorable correlation between farmer irrigation techniques and landholding. The differing conclusions regarding the amount of cultivable land were brought about by variations in the underlying circumstances in the regions where those researchers conducted their research. For instance, Edo (2014) discovered that there was a negative link between land ownership and irrigation practice, and that this association was caused by farmers with larger plots of land dedicating more of their land to animal husbandry and rain-fed crops. Beyan et al. (2013), revealed that, fragmentation of cultivable land is a problem of crop diversification for most of the farmers in the study area.

Other studies indicate that farm size is found positively affecting participation in irrigation practice by smallholder farmers (Abebaw et al., 2015; Sithole et al., 2014). According to these sources, farmers with big farms were found to participate in irrigated farming more frequently than their counterparts. However, the researchers have not provided an explanation for this finding, which has a positive substantial impact on the participation decision of the families. This variable also demonstrates a favorable impact on the land area that farmers set aside for irrigation (Wang et al., 2015).

Oxen ownership also influences the small-scale irrigated farming decision positively (Gebrehaweria et al., 2014). This finding was related with the risk taking behavior is more for wealthier farmers as compared to poor farmers. Even though it is not explained, this result might be related with the source of draft power used in preparing the land for irrigated farming. The farmers with larger number of oxen can use their oxen for preparing the irrigation farm easily and the households with lower number of oxen may face difficulty in land preparation and may not be able to participate in irrigated farming.

The amount of cattle that each household held had a positive, significant impact on their decision to participate in irrigation (Hadush, 2014). It was discovered that farmers who had higher TLU had a higher likelihood of using irrigation. The aforementioned result generally demonstrates that farmers who had higher values for the variable were found to engage in irrigation activity more frequently than those who had lower values.

Further research by various researchers found that the household head's educational status had a positive, significant impact on farmers' decisions regarding irrigation practice (He et al., 2007; Tewodros et al., 2013; Muhammad et al., 2013; Edo, 2014; Nhundu et al., 2015; Abebaw et al., 2015).

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Further research by various researchers found that the household head's educational status had a positive, significant impact on farmers' decisions regarding irrigation practice (Tewodros et al., 2013; Muhammad et al., 2013; Edo, 2014; Abebaw et al., 2015). This implies that farmers who attended more irrigation technology training were found with higher probability of participating in irrigation practice than their counterparts.

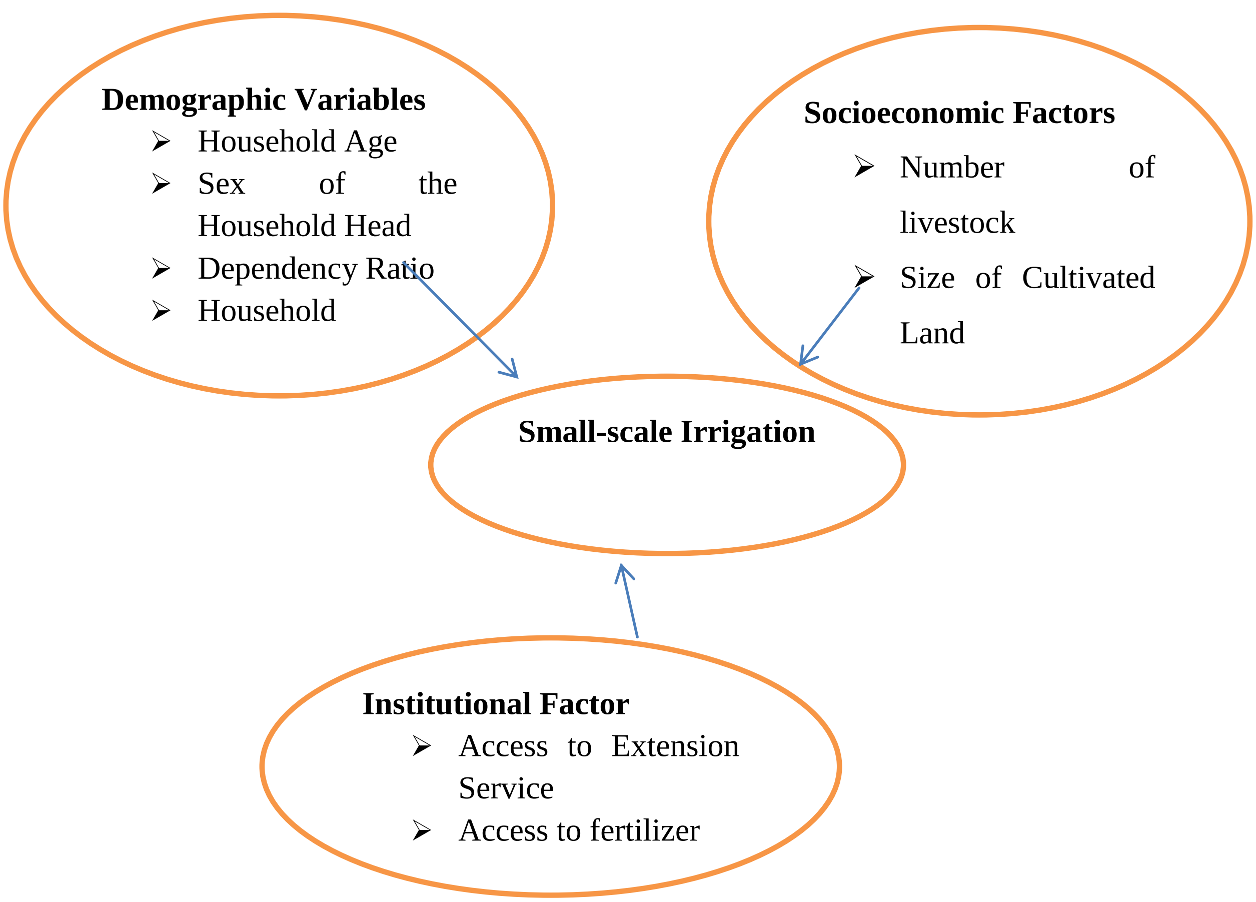
2.3. Conceptual Framework of the Study

The conceptual framework of household food security determinant factors is crucial in understanding the various variables that affect food security in households. Demographic variables such as household age, sex of the household head, and dependency ratio play a significant role in determining food security. For instance, households with a higher dependency ratio may have limited access to food due to the increased demand.

Household and socioeconomic factors such as the number of livestock and size of cultivated land also affect food security. A household with a larger livestock population may have a higher income level, leading to better food security. Additionally, households with larger plots of cultivated land have a higher chance of producing more food, leading to improved food security.

Institutional factors such as access to extension services and fertilizers play a crucial role in ensuring food security. Access to extension services provides households with technical knowledge on agricultural practices, while access to fertilizers improves crop yields.

In conclusion, the conceptual framework of household food security determinant factors highlights the importance of various factors in ensuring food security in households.



Developed by the researcher (2023)

CHAPTER THREE

3. METHODOLOGY

3.1. Description of the Study Area

The study area is located in Amibara Woreda, Melka Werer kebele, which is part of the Administrative Zone 3 in the Afar region of Ethiopia.

Amibara wereda is bordered by Awash Fentale District (south), Awash River (west), Administrative Zone 5 (northwest), Gewane (north), Somali region (east), and Oromia region (southeast). The study areas are located between 39°40'and 40°40'E (Figure1). It has total areas of 2,007.05km2 and the climate of the area is hot and semi-arid. The mean annual temperature is estimated at 27.9oC.

About 90 percent of the Afar population practice pastoralism (Afar Atlas, 2014). Pastoralists in all the areas covered in this study practice pastoralism, relying on livestock production as their main livelihood. All major species of livestock, including camel, cattle, sheep and goats, are kept. (Afar Atlas, 2014)

Most of the people of this region are pastoralists and have experienced severe food insecurity for many years. According to the Afar Bureau of Food Security, there were about 562,080 individuals with food security difficulties. This is due to varied climatic conditions, traditional production system, poor regional development policy and lack of sound research in the study area. (EWVCDP, 2023)

Based on the 2021 Census conducted by the Central_Statistical_Agency of Ethiopia (CSA), this woreda has a total population of 18,232 of whom 9,721 are men and 8,511women. The land use indicator study suggests that about 7.0% of the total area of the region is suitable for crop production; and 22.4% of the total area of the region could be developed for agricultural activity. However, only about 1.2% of the total area of the suitable area is used. The climatic condition of the region is mostly hot, desert type and partially dry. As a result the region exhibits high temperature, and low rainfall that is not distributed uniformly. The precipitation is sporadic, exhibiting inadequate dispersion throughout the regions and fluctuating annually. The majority of irrigation practices in these localities are conventional, while some public and private ventures in irrigated farming implement advanced irrigation techniques such as sprinkler and drip systems.

According to research, Amhara has access to 24.11% of irrigable land, Oromia has access to 38.85%, and the Afar region has the lowest access at only 0.12%. The Afar region has been found to have a less developed irrigation system compared to other regions. However, the Amibera district within the Afar region has better small-scale irrigation practices than other districts, with Melkasedi and Ambash irrigation schemes and Werer Agricultural Research Center station being the largest and most significant agricultural practices in the middle Awash River Basin. In the lower Awash River Basin, small-scale irrigation farms are present, but most of the area is arable. The primary crops grown in Worda include cotton and cereals like wheat, maize. Sorghum, teff, and barley; pulses such as haricot bean, bean, field pea, and Fabian; and vegetables like onion, potato, cabbage, and tomato. Amibera woreda especially Melkewerer kebele was selected for study, because it is known to small scale irrigation usage trend user and still it was noticed that there was a problem of adoption. Its usage was not extended as usual as it has to be. There exists more significant number of non-user compared with users and the researcher anticipated to undertake factors affecting the kebele residents in adopting small scale irrigation usage.

This study aims to examine the factors affecting small-scale irrigation use of households in Werer kebele within the Amibera district.

Maps 1:- Study area location map

3.2. Sources and Methods of data collection

The study used both primary and secondary data sources. Primary data was collected directly from the respondents who were selected from users and non-users of irrigation in designated kebele on the way of questioners.

Thus, to evaluate the impact of small-scale irrigation on household food security in the Afar region of Ethiopia, quantitative data on various factors was collected. These include information on the socio-demographic and socio-economic characteristics of households, and the food security status of both treatment and control groups.

This data was gathered through questionnaires administered to a representative sample of households. Secondary information that could supplement the primary data were collected from published and unpublished documents obtained from, zone 3 Irrigation Development Authority, Amibara Agricultural and Rural Development office, Amibara Woreda administration, Ministry of Finance and Economic Development, Afar Irrigation Development Authority.

3.3. Sampling Procedure and Sample Size

3.3.1. Sampling techniques

To gather the sample for this study, a three-stage sampling method was utilized. Firstly, the study Woreda was purposely chosen. Secondly, kebele that had access to small-scale irrigation were randomly selected. Finally, households in the selected kebele were divided into two strata-irrigation users and non-users from which a random sample was selected. The researcher used stratified sampling in the second stage to randomly select households from each stratum. This technique involves dividing the total population into smaller groups or strata. Ultimately, respondents who used or did not use irrigation were randomly selected from each stratum using household sampling.

3.3.2. Sampling Size Determination

Sample size was determined by using the formula for sample size determination by Kothari, C.R. (2004).

$$n = \frac{Z^2 * p * q * N}{e^2(N-1) + Z^2 * p * q}$$

Where; n= Sample size

N= population size

Z= confidence level of 95% which is 1.96

P= sample proportion and q= (1-p) which becomes 0.5

e= error term which is 0.05

$$n = \frac{(1.96)^2 * 0.5 * 0.5 * 18232}{(0.05)^2(18232 - 1) + (1.96)^2 * 0.5 * 0.5}$$

$$n = \frac{17510.0128}{46.5379}$$

$$n = 376.25 \approx 376$$

3.4. Data Analysis Techniques

3.4.1. Data Analysis Methodology

For the purpose of this study, a combination of descriptive and econometric methods was employed to analyze the data. After collecting data using questionnaires and conducting a thorough review of relevant documents, the collected data was entered into the computer using SPSS software version 16 and subjected to analysis.

3.4.2. Descriptive Statistics

To provide a comprehensive overview of the socioeconomic, demographic, and institutional characteristics of the sampled households, descriptive statistics such as mean, standard deviation, minimum, maximum, percentages, frequency, tables, and graphs were utilized.

3.5. Econometric Models

3.5.1. Binary Regression Model

To identify factors affecting use of small-scale irrigation at household level in the Afar regional state Amibera woreda: in case of Melka werer kebele, a binary logistic regression model was employed. The reason for the selection of this model is it is a relevant and well known model to be used when the dependent variable is binary or categorical which means, it can only take two possible values and when the determinant variables are both categorical and continuous.

Variables of the Model

This section addresses the variables that were expected to influence the use of small-scale irrigation at household level in the Afar regional state Amibera woreda: in case of melka werer kebele.

3.5.1.1. Dependent Variable:

The first stage of this study focuses on the dependent variable, use of small-scale irrigation. It is represented as a binary variable, with a value of 1 denoting households with access to irrigation and 0 otherwise, in the study area. It is assumed that the dependent variable is influenced by various independent variables. Each variable is defined with a hypothesis derived from economic theory and the findings of previous empirical studies.

3.5.1.2. Independent Variables

The independent variables hypothesized to have an impact on the use of small-scale irrigation of households. Encompass a combination of factors, including demographic, socioeconomic, technological, and institutional factors.

Demographic and Socioeconomic Variables:

Household Age (HEADAGE): Age is measured as a continuous variable in years and is considered a significant factor in individuals' decision-making processes. A negative relationship is expected between the age of the household head and participation in the irrigation scheme. Because, most of the time as the age increases, the interest in adopting new technologies decreases. An also, there would be lack of physical labor to participate in irrigation system.

Sex of the Household Head (HEAD SEX): it is a dummy variable, 1 for male headed households and 0 for female headed households. Male-headed farmers are assumed to be more proficient than female-headed farmers, given the assumption that male household heads have greater exposure to information and access to new interventions for various reasons, which enables them to participate in small-scale irrigation. This study hypothesizes that male-headed households are more inclined to participate in the small-scale irrigation scheme in the study area.

Number of dependents (DEPNU): Number of dependents is a continuous variable that indicates the household members who rely on the active members of the family for support. It is hypothesized that as the number of dependents increase in a family, there would be lack of available working labor to participate on the irrigation field.

Household Education Level (HHEDU): It is a continuous variable that represents the number of years of schooling completed by the sampled households' heads at the time of the survey. Previous studies have shown that higher education levels are associated with a greater likelihood of adopting new farming methods. Educated farmers are more inclined to adopt irrigation technology, are more receptive to extension support and training, and have a positive influence on irrigation participation. However, higher levels of education may also lead to increased interest in non-agricultural activities, potentially reducing willingness to participate in contract farming programs. Therefore, this variable is hypothesized to have both negative and positive effects on participation decisions.

Access to fertilizer (ACCFERT): it is a dummy variable, 1 for access to fertilizer and 0 otherwise. Access to fertilizer is an important variable that can affect rural households' decision to participate in small-scale irrigation schemes. In areas with limited access to commercial fertilizers, farmers may have lower crop yields and face challenges in expanding their agricultural activities. Therefore, access to fertilizer can significantly contribute to the success of small-scale irrigation projects. The study will investigate the impact of access to fertilizer on small-scale irrigation practices.

Family Size (HHSIZE): Family size is a continuous variable. Previous studies have found a bidirectional relationship between family size and the decision to participate in irrigation schemes and other agricultural technologies. Family size with a working force are expected to use irrigation because, the family could be informative and also be able to have a working labor in the irrigation field. But, if the family size have more non-working force the probability of participating in irrigation becomes less.

Access to Extension Service (ACCEXT): This variable indicates whether the household head receives extension services from development agents (DAs) or not. Extension services provide farmers with the necessary information and knowledge to improve agricultural production. Bacha et al. (2011) found a significant difference between irrigators and non-irrigators in terms of access to extension services, with a higher probability for farmers to access and use irrigated agriculture. Therefore, this variable is hypothesized to positively influence participation in the small-scale irrigation scheme.

Size of Cultivated Land (CUTLAND): it is a continuous variable. This variable represents the total size of cultivated land (both irrigated and rain fed) owned by a household, measured in hectares. It is expected that that household with a larger size of cultivated land would participate in small-scale irrigation than those who have smaller size of cultivated land.

Livestock Holding (LIVESTOC): it is a continuous variable. Increased livestock holding is expected to have a positive relation with irrigation use in some studies. But, in the case area of this research, as the place is known for having most households who are pastoralist, it is also expected to have a negative relation with the dependent variable, for it is assumed, having a large amount of livestock may decrease the interest of participating in irrigation.

Table 3.1 Definition of independent variables

VARIABLES	DEFINITIONS
IRRIUSAGE	Irrigation usage of the household/It is a dummy variable that takes a value of 1 if the household has access to irrigation, 0 otherwise
HEADAGE	Age of household head measured in years/20-35, 36-45, 46-55, >55
HHSIZE	Household size in number of household members/ It is a continuous variable/
HEADEDU	Education of the household head in category/illiterate, grade 1-8, grade 8-12 and >12
SEXHEAD	Sex of the household head/ This is a dummy variable which takes a value of 1 if the household head is male and 0 otherwise
CUTLAND	Cultivated land size (both irrigated and rain fed) in hectare/ It is a continuous variable/
LIVESTOC	Total livestock holding measured in Tropical Livestock Unit/ It is a continuous variable/
DEPNU	Number of dependents in a household/It is a continuous variable/
ACCFERT	Access to fertilizer/It is a dummy variable, take 1 if the household gets access to fertilizer and 0 otherwise
ACCEXT	Access to extension service of the household/ It is a dummy variable, takes a value of 1 if the household gets access to extension service and 0 otherwise

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Descriptive Statistical Results of the Model Variable

4.1.1 Family Size

Table 4.1 Family size of respondents

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	3	23	10.2
		4	95	42.0
		5	107	47.3
		6	1	.4
		Total	226	100.0
irrigation user	Valid	3	13	8.7
		4	73	48.7
		5	64	42.7
		Total	150	100.0

Source: - own survey 2023

From the above table's information among 376 of households 150 are irrigation users, while 226 households are irrigation non-users. 5 and 4 family sizes constitute the highest frequency of the irrigation user household size. Like the irrigation users, the irrigation non-users highest frequency of household size is 5 and 4.

4.1.2. Sex of Household Head

Table 4.2 Sex of Household Head

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	female	55	24.3
		male	171	75.7
		Total	226	100.0
irrigation user	Valid	female	21	14.0
		male	129	86.0
		Total	150	100.0

Source: - own survey 2023

According to the above table, both the irrigation users and irrigation non-users has more number of male than female. From the irrigation users 86% of the total population is male and 14% female. And the irrigation non-users constitutes 75.7% of the total population is male and 24.3% female.

4.1.3. Education level of Household Head

Table 4.3 Education level of Household Head

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	illiterate	54	23.9
		1-8	122	54.0
		9-12	50	22.1
		Total	226	100.0
irrigation user	Valid	illiterate	28	18.7
		1-8	68	45.3
		9-12	51	34.0
		>12	3	2.0
		Total	150	100.0

Source: - own survey 2023

In the study area, 45.3% of the irrigation users found to be attained grade 1-8, which constitutes the highest percentage of the education level of the irrigation users. On the other hand, grade 1-8 constitutes 54% of the population under the irrigation non-users. According to the test made, education level of household has a positive relationship with irrigation.

4.1.4. Number dependents per household

In the case area, 28.7%, 36.7% and 24.0% of the irrigation users constitutes 3, 2 and 1 number of dependents per household respectively. Whereas, from the irrigation non-users, 33.2%, 41.6% and 19.0% has 2, 3 and 1 number of dependents per household respectively.

4.1.5. Size of Land Holding

Table 4.4 Size of Land Holding

Statistics

size of cultivated land

irrigation non user	N	Valid	226
		Missing	0
	Mean		.6887
	Minimum		.36
	Maximum		.88
irrigation user	N	Valid	150
		Missing	0
	Mean		.7091
	Minimum		.50
	Maximum		.93

Source: - own survey 2023

In the sample taken, the minimum land size is 0.36 hectare and the maximum is 0.93 hectare. From this, the mean land size of irrigation users is 0.70 hectares and the mean land size of irrigation non-users is 0.68 hectares.

4.1.6. Live stock holding of the household

Higher number of livestock holders tends to have an increased number of participation in irrigation when compared to lower number of livestock holders in some areas. But, as the result of this study, higher number of livestock holders tends to ignore the irrigation system and focus on their pastoralist life style.

4.1.7. Access to Extension Service

From the total sampled irrigation users 67.3% has access to extension service and the rest 32.7% does not have access to extension service while, 58% of the non-irrigation users has access to extension service and the rest 42% does not have extension service. This is can be seen in the following table:-

Table 4.5 Access to Extension Service

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	extension non-user	95	42.0
		extension user	131	58.0
		Total	226	100.0
irrigation user	Valid	extension non-user	49	32.7
		extension user	101	67.3
		Total	150	100.0

Source: - own survey 2023

4.1.8. Access to Fertilizer

Table 4.6 Access to Fertilizer

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	don't have access to fertilizer	90	39.8
		have access to fertilizer	136	60.2
		Total	226	100.0
irrigation user	Valid	don't have access to fertilizer	37	24.7
		have access to fertilizer	113	75.3

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	don't have access to fertilizer	90	39.8
		have access to fertilizer	136	60.2
		Total	226	100.0
irrigation user	Valid	don't have access to fertilizer	37	24.7
		have access to fertilizer	113	75.3
		Total	150	100.0

Source: - own survey 2023

As it is revealed in the above table, 75.3% of irrigation users have access to fertilizer while the rest 24.7% of irrigation users don't have access to fertilizer. On the other hand, 60.2% of irrigation non-users have access to fertilizer and the remaining 39.8% of irrigation non-users don't have access to irrigation.

4.1.9 Age of household head

Table 4.7 Ages of Household Head

irrigation usage of household			Frequency	Percent
irrigation non user	Valid	20-35	101	44.7
		36-45	77	34.1
		46-55	44	19.5
		>55	4	1.8
		Total	226	100.0
irrigation user	Valid	20-35	84	56.0
		36-45	46	30.7
		46-55	20	13.3
		Total	150	100.0

Source: - own survey 2023

From the total sample of irrigation users 56%, 30.7% and 13.3% are aged between 20-35, 36-45, and 46-55 respectively. And from the total sample of irrigation non-users 44.7%, 34.1% , 19.5% and 1.8% are aged between 20-35, 36-45, 46-55 and >55 respectively.

4.2. Econometric analysis

4.2.1. Binary Regression Model

To identify factors affecting irrigation use, there must be an analysis of each independent variable which is structured as possible factors. To do the analysis, we need to have a dependent variable and independent variables. To do the analysis, a binary regression model is applied.

To do the analysis, binary regression model is used, where the dependent variable was regressed against age of household head, education level of household head, sex of household head, family size, number of dependents in the household, size of cultivated land, livestock holding, access to extension service and access to fertilizer.

4.2.2. Variables in the equation

Table 4.8 variables in the equation

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	HEADAGE	-.299	.151	3.942	1	.047	.741
	HEADSEX	.715	.297	5.793	1	.016	2.045
	DEPNU	-.216	.133	2.626	1	.105	.806
	HEADEDU	.346	.159	4.736	1	.030	1.414
	HHSIZE	.071	.183	.151	1	.698	1.074
	EXTSER	.450	.240	3.497	1	.061	1.568
	CUTLAN	2.349	1.095	4.605	1	.032	10.472
	LIVSTO	-.506	.212	5.686	1	.017	.603
	ACCFERT	.626	.250	6.264	1	.012	1.869
	Constant	-2.385	1.317	3.280	1	.070	.092

a. Variable(s) entered on step 1: HEADAGE, HEADSEX, DEPNU, HEADEDU, HHSIZE, EXTSER, CUTLAN, LIVSTO, ACCFERT.

Source: - own survey result 2023

As it is indicated on the above table:-

Age of Household Head has a negative relation with the dependent variable, irrigation use. It means, as the age of household head increases, participation in irrigation decreases. The assumption behind this result is, as the age of household head increases lack of physical ability to participate in irrigation, unwillingness to participate in new system, lack of information would appear. And these results in not participating in irrigation as the age increased.

Sex of Household Head has a positive relation with irrigation use. As it is visible on the table above, male-headed households have an increased probability of participating in irrigation than female-headed households. It is because males have a higher tendency to get information from other households around the community and being informed about irrigation. And also males are better participants in physical labor oriented work than females.

Number of dependents has a negative relation with irrigation use. As the number of dependents increases, participation in irrigation decreases because, lack of labor would result in lack of interest to participate in small-scale irrigation, which needs labor.

Education Level of Household Head has a positive relation with small-scale irrigation. As the level of education increased there would be a higher possibility of getting information, knowledge and skill about the use of irrigation which would result in high interest of participating in irrigation.

Household Size has a positive relation with irrigation. As the household size increased there would be higher probability of participating in irrigation. Because there would be plenty of labor force to work on the small-scale irrigation.

Access to Extension Service has a positive relation with irrigation use. Extension service provides information, knowledge and skill to participants. One of the knowledge given is about small-scale irrigation. So households who participate in extension service have a higher probability of participating in small-scale irrigation.

Size of Cultivated Land has a positive relation with irrigation use. As the size of cultivated land increases use of small-scale irrigation increases because farmers who have large land size tends to focus and work on the land to get more crop and output. To get the wanted output they use the available facilities including small-scale irrigation.

Livestock holding has a negative relation with irrigation use. As the amount of livestock increases, the probability of participating in irrigation decreases. Some previous research results show that higher livestock holders have higher participation in irrigation use. But, according to this case, higher livestock holders have a less probability of participating in small-scale irrigation. This could be a resulted from, the lack of interest to participate in small-scale irrigation as the number of livestock increased, because their main focus would be on rearing their livestock than using irrigation to the farm.

Access to Fertilizer has a positive relation with irrigation use. This might be because of the willingness to make an effort to the farm land to get a better output with the use of fertilizer and irrigation together. And mostly households who have access to fertilizer have a better knowhow about modern the farming system which also includes irrigation system.

CHAPTER FIVE

5. CONCLUSION AND REC0MMENDATION

5.1. Conclusion

The study aimed to evaluate factors affecting small-scale irrigation in Amibera woreda: in case of Melke werer kebele in the Afar region. Using a multi-stage sampling technique, the study collected primary and secondary data from chosen kebele representing 376 households. Out of the 376 households 226 are non-irrigation user households and 150 irrigation user households. The data were analyzed using descriptive and econometric techniques, including binary regression model.

The findings showed factors as sex of household head, access to extension service, and access to fertilizer, family size, household education level, and size of cultivated land affects the use of irrigation positively. On the other hand, age of household head, number of dependents and number of livestock holding has a negative relation with the dependent variable irrigation use.

The results show that, information and knowledge about the irrigation system has a very higher impact on the use of irrigation. Knowledge and skill have a positive impact on irrigation participation. The most factors are indirectly related with acquiring knowledge about the irrigation system. As a person is knowledgeable, he/she would prefer the light than the darkness.

5.2. Recommendations

The following suggestions are put up to indicate and recommend the factors that affect the use of irrigation.

1. Promote education and training: Efforts should be invested in education and training programs that concentrate on small-scale irrigation practices because there is a positive association between household head education and irrigation adoption. The possibility of adoption can be increased by helping to improve knowledge and abilities.

2. Target extension services: Access to extension services has a positive relationship with irrigation use. As a result, initiatives should be taken to increase access to these services, such as by offering instruction, technical support, and knowledge of irrigation methods.

Farmers can learn from this about the advantages of small-scale irrigation and its best practices.

3. Support access to fertilizers: Access to fertilizers has been found to have a positive relationship with irrigation adoption. Fertilizers are essential for increasing agricultural yield when used in a combination with irrigation, thus it's critical to make sure farmers have easy access to them.

4. Address gender disparities: The use of irrigation is positively correlated with the gender of the head of the household. Specific interventions, like giving women equal access to resources, training, and decision-making processes, should be put into place to promote gender equality and increase female engagement in irrigation.

5. Encourage farmers to engage in small-scale irrigation: Given that small-scale irrigation agriculture has the potential to increase food security and dietary diversity, government agencies and non-governmental groups should aggressively encourage and support farmers to engage in this practice.

By implementing these recommendations, policymakers, agricultural organizations, and local communities can collaborate to harness the potential of small-scale irrigation, leading to sustainable food security in the study area and similar regions.

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Appendix I: Questionnaire for Respondents

Dear Respondent

The purpose of this questionnaire is to gather factors affecting use of small scale irrigation at household level in the Afar Regional state, Amibera wereda in case of Melka werer kebele. This study is going to be conduct for the partial fulfillment requirement for the Degree of Master of Art in Development Economics. Your full support and willingness' to respond to the question is very essential for the success of the study. Therefore, you are kindly requested to answer all questions and give clear, appropriate and reliable information on the issues. Be sure that the information you provide is only for the purpose of this study. Thanks you.

Date of interview (dd/mm/yy) ___________ / _________ / ____________

Kebele: - _____________

Name of interviewer: - ________________________ Signature _____________

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

HH member ID	3.1 Name	3.2 Sex 1	Age (in years)	Education/l evel/ status
001				
002				
003				
004				
005				
006				
007				
008				
009				

Appendix II Table 1

1. Demographic characteristics

Sex: 1 Male 2 Female

Marital Status: 1=Single 2=Married 3= Divorced 4= Widow 5 = Others

Relationship to household head: 1=Head 2=Husband 3=Wife 4= Daughter 5= Son 6= grand Father 7= Grandmother 8= others

Religion: 1= Orthodox 2= Protestant 3= Muslim 4 = Others

Level of education: 1= Literate (read & write) 2= Grade 1-4 3= Grade 5-7 4 = Above Grade 8- 5= Illiterate

Occupation: 0=Farmer 1=civil servant 2=Trader 3=Housewife 4=Construction 5=Weaving 6=Carpentry and 7= others

2. **Livestock holding during 2023**

Table2. Summary of Livestock holding

Do you have livestock? 0. No 1. Yes

2.1. If yes for Q#2.1, indicate the number of livestock in the following table

Types of Livestock	Number Owned	Number Sold	Income Obtained
Oxen			
Camel			
Cows			
Goat			
Goat (Young			
Calves			
Sheep (Young)			
Sheep (Adult)			
Donkeys (Adult)			
Donkeys (Young)			

Bulls			
Heifers			
Horses (Adult)			
Horses (Young)			
chicken			
Poultry			

Codes & No Livestock: Oxen 1.Cows 3. Calves 5. Heifers 12.Sheep 5 Goats 4. Chicken 13.Horse 10.Mule 11.Donkey 10.Camel 3.Others

3. Agricultural Extension

3.1. Have you received any institutional support for small-scale irrigation? Yes _____ No_____

3.2. Have you received access to fertilizers for your irrigation practices? Yes _____ No_____

3.3. Have you received access to extension services for guidance and support? Yes _____ No_____

3.4. How satisfied are you with the institutional support provided? Yes _____ No_____

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

3.6. If yes, how far is the FTC from your home _______________ in Km?

3.7. Do you contact with DA/ Development agent? 1. Yes 2. No

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

4. **Use of small scale irrigation**

4.1. How many times do you produce per year using irrigation? ____________

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

1. Yes 0. No

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

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

4.5. Ponds 4. Well 5. Other, specify ______________

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

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

5. Socio-Economic status of the household

1. What is the total farm land you have (owned)? A) 0.2-0.5h B) 0.6-0.8h C) 0.9-1h D) Above 2h

1.2. How much of your land is used by small scale irrigation? A) 0.125-0.25h B) 0.26-0.5h C) 0.5-0.75h D) More than 0.75h

2. Have your own active family members participated in farm activity? Yes _____ No_____

2.1. If yes, what type of activity they are engaged in? A) Weeding B) harvesting C) threshing D) watering E) planting F) ploughing

3. What are the main sources of the labor for your small scale irrigation activity? A) Family labor B) hired labor

3.1. Did you face any labor shortage during the last cropping/production season? Yes _____ No_____

3.1.1. If yes, how did you solve the labor shortage? A) Through hiring additional daily laborers

Access to extension service (Institutional Support and other related services)

2. Do you have access to extension services? Yes _____ No_____2.2. If yes, where do you obtain extension services? A) Development agent B) NGO C) Media D) Woreda agricultural office

2.3. Do you receive any sort of extension services by agricultural development agents? Yes _____ No_____2.3.1 If yes, around what topic? A) Agronomic practices B) IPM C) Post harvest

D) Applying agricultural inputs

3. Have you get any type of training on small scale irrigation utilization means? Yes _____ No_____

3.1. If yes, by whom the training was given? A) Trained farmers B) by agricultural expert C) by local NGOs working on the irrigation development D) DA

3.2. Do you think the training given was sufficient? Yes _____ No_____

3.3. If no, if possible what type of training you want to be added? A) Appropriate method of irrigation land B) Demonstration C) Manipulation of water pump

APPENDIX V

Conversion factor for Tropical Livestock Unit (TLU)

Livestock Type	**TLU**
Ox	1.00
Cow	1.00
Heifer	0.75
Bull	1.00
Calf	0.25
Sheep	0.13
Goat	0.13
Donkey	0.70
Horse	0.75
Poultry	0.013

Source: Abdinasir, Ibrahim (1991)