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Determinants of Smallholder Farm Households Small Scale Irrigation Practice and Its Effect on Farm Income in West Gojjam Zone: The Case of Yilmanadensa Woreda

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DETERMINANTS OF SMALLHOLDER FARM HOUSEHOLDS SMALL SCALE IRRIGATION PRACTICE AND ITS EFFECT ON FARM INCOME IN WEST GOJJAM ZONE: THE CASE OF YILMANADENSA WOREDA

By

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A THESIS SUBMITTED TO THE DEPARTMENT OF ECONOMICS, COLLEGE OF BUSINESS AND ECONOMICS, BAHIR DAR UNIVERSITY

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APPROVAL SHEET

The thesis entitled "Determinants of smallholder farm households small scale irrigation practice and its effect on farm income in west gojjam zone: the case of Yilmanadensa woreda" By Birhanu Alamirew is approved for the degree of Master of Science in economics.

Board of Examiners

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External examiner	_____	_____

Date_____

DECLARATION

I, the undersigned, declare that this master thesis entitled "Determinants of smallholder farm households small-scale irrigation practice and its effect on farm income in west gojjam zone: the case of Yilmanadensa woreda" is entirely my original work and it has not been submitted or presented for a degree in any other university for any academic purpose. Besides, that all sources of materials used for the thesis have been duly acknowledged.

Name: Birhanu Alamirew

Signature: _____

Date: _____

Place: Bahir Dar University

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LIST OF ABBREVIATIONS AND ACRONYMS

ACSI	Amhara credit and saving institute
ADLI	Agricultural Development Led Industrialization
BOARD	Bureau of agriculture and rural development
BOWRD	Bureau of water resource development
BWMERD	Bureau of Water, Minerals, and Energy Resources Development
CC	Contingency coefficient
CSA	Central statistical authority
DOID	District office of irrigation development
FAO	Food and agricultural organization
GDP	Gross domestic product
GTP	Growth and Transformation Plan
HHs	Households
IDD	Irrigation development department
IMF	International monetary fund
IWMI	International water management institute
LPM	Linear probability model
LSI	Large scale irrigation
MNRDEP	Ministry of Natural Resources Development and Environmental Protection
MOA	Ministry of Agriculture
MOANR	Ministry of agriculture and natural resource
MOARD	Ministry of agriculture and rural development

MOFED	Ministry of Finance and Economic Development
MOWE	Ministry of water and energy
MSI	Medium scale irrigation
NGO	Non-governmental organizations
OLS	Ordinary list squares
PASIDP	Participatory Small-Scale Irrigation Development Programme
SSA	Sub-Saharan African
SSI	Small scale irrigation
SWCD	Soil and Water Conservation Department
TLU	Tropical live stock unit
UNDP	United nation development program
USD	United states dollar
VIF	Variance inflation factor
WB	World Bank

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ABSTRACT

Small scale irrigation is one of the most useful irrigation systems designed to increase production and productivity. Despite these, however, smallholder farmers in the study area are not using small scale irrigation schemes. Therefore, the study was focused on assessing the determinants of small scale irrigation practice and its effect on household farm income in Yilmanadensa woreda. The total population in the selected four kebeles of the woreda was stratified in to two strata (irrigation user and non-user). Then two stage sampling was employed to select sample respondents. Results are based on data collected from a survey of 178 randomly selected rural farm households. Descriptive statistics and Heckman two-stage estimation methods were employed. The result shows that access to market information, sex of the household head, access to extension service, education level of the household head and distance from households' residence to the nearest market are important determinants for small scale irrigation practice. The analysis further revealed that access to irrigation, access to credit service, total livestock holding and distance of the household residence from the nearest market is significantly associated with household total farm income. Generally improving access to market information, gender equality, access to extension service and education level of the household is better to enhance small scale irrigation practice which in turn improves households total farm income.

Key words: small scale irrigation, Heckman two stage model, Yilmanadensa

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Irrigation is one method of agricultural intensification and plays dominant role in increasing agricultural productivity in every country. In the recent time it is obvious that, small scale irrigation is one of area of emphasis by policy makers and development planners. Though Sub Saharan Africa has a rich and varied water endowment, only four percent of its cropland is irrigated. Some 40 million hectares of its land are suitable for irrigation, but only 7.3 million hectares are actually irrigated. (IWMI, 2012).

In many parts of the world including Ethiopia, the amount, frequency and distribution of rainfall, which is the principal source of water for crop production, is becoming more unpredictable and inadequate. Irrigation practice supports successful crop growing and stabilizes crop yields. In other words, irrigation is required in most of the places having uncertainty and uneven distribution of rainfall. In drought prone areas of the country successful crop production is only possible with the support of irrigation practice (MOA, 2010).

Scaling up the use of these smallholder irrigation systems should rise to the top of African development priorities. With targeted investments and policies to expand decentralized irrigation, the future for sub Saharan Africa's smallholder farmers could be vastly different. Without them hunger, poverty and humanitarian crises will persist (IWMI, 2011). It insulates the national agricultural economic sector against weather related shocks and provides a more stable basis for economic growth and poverty reduction in that country. However, the agricultural productivity is low due to use of low level of improved agricultural technologies, risks associated with weather conditions, diseases and pests, and the like (Alemerie et al, 2014).

Agricultural production in our country is primarily rain fed, so it depends on erratic and often insufficient rainfall. As a result, there are frequent failures of agricultural production in Ethiopia. Irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall. Irrigation development also can help offset some of the negative effects of rapid population growth (2.6% per year in Ethiopia) (Awulachew etal, 2005).

The modern history of Ethiopia shows that the country has failed to adequately feed itself. Agrarian society of Ethiopia is not doing well in terms of agriculture and need transformation in increasing production, increase productivity and make sustainable agriculture that could cope with population growth, withstand climatic variability and limit agricultural expansion to marginal land. One of the ways to do so is through improved management of agricultural water and irrigation development, particularly small scale irrigation benefiting small holders (IWMI, 2011).

Ethiopia experiences impressive record of growth and poverty reduction in recent years, with GDP growth averaging 10.1 percent in 2010/11-2014/15 and about 8 percent GDP per capita growth. However Food deficit and famine occurrences in the country is claimed to be as a result of the erratic nature of rainfall or drought. Ethiopia has faced large-scale drought induced food shortage and famine in recent times that includes drought in 1972/73, 1983/84, 2002/03 and 2015/16 when the country faced adverse exogenous shocks which claimed thousands of lives. In a country where 85 percent of the people are farmers, millions were in need of aid. By November 2015 the government had purchased nearly 1 million metric tons of wheat at a cost of about $280 million (IMF 2016).

Currently, the Ethiopian government is trying to transform from traditional and manual, rain fed, supply driven and production oriented agriculture to technology intensive and mechanized, irrigated, market oriented agriculture, through full packages of value addition and post-harvest technologies with different projects. To this end, the first phase of the Participatory Small-Scale Irrigation Development Programme (PASIDP-I) was implemented from 2008-2015 with the objective of reducing Ethiopia's agriculture vulnerability to adverse weather conditions and drought, and to reduce rural poverty and food insecurity. A second phase of the Programme (PASIDP-II) consistent with goals and objectives of the Second Growth and Transformation Plan (GTP II), namely: increased and market-oriented crop production and productivity; increased livestock production and productivity; reduced degradation and improved productivity of natural resources; and enhanced food security (MOANR, 2016).

Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation and growth (CSA, 2007), only around 5% of Ethiopia's irrigable land is irrigated and less than 5% of total

renewable water resources are withdrawn annually (Graciana, 2011) so there is considerable scope for expansion. Ethiopia has a potential of 5.3 million hectare arable land that can be cultivated through irrigation water (MOFED 2006). Considering the land and water resources potential the country has, massive volume of works have been undergoing with a view to ensuring food security both family-wise and nationally and to further increase agricultural outputs and earn foreign currency (Mujere et al ,2010).

Irrigation contributes to agricultural production in two ways: increasing crop yields, a enabling farmers to increase cropping intensity (Zhou et al. 2009). Irrigation benefits the poor households through higher production, higher yields, and lower risk of crop failure, higher and year-round farm and non-farm employment (Asayehegn et al., 2011). Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation and economic growth (MOFED, 2006). The current government of Ethiopia has undertaken various activities to expand irrigation activity in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable development of the country.

The Amhara region, with a population of about 18 million, is the second most populous administrative region in Ethiopia (CSA, 2007). Like other regions of the country, the economy of Amhara is largely dependent on agriculture with small holder cultivation of cereals, pulses, horticultural crops and oilseeds mainly characterized by subsistence farming and mixed with livestock rearing. Some drought-prone areas of the region are food insecure due to a combination of factors such as erratic and unreliable rainfall, high population density and low productivity caused by poor agricultural management practices. In the region, an estimated around 18-20% of the population is chronically food insecure (BoARD, 2003).

In Yilmanadensa woreda surface irrigation is the predominant form of irrigation; it includes river diversion, motor pumps, micro dams and pond systems. Since, climate and irrigation technology are changed through time it needs revising the policy of small scale irrigation in particular and agriculture in general. This study could serve as the input to policy makers when they revise the irrigation policy. The study identify and analyze factors that determine small holder farmers, small-scale irrigation practice and its effect on farm income in Yilmanadensa woreda of west gojjam zone in Amhara region

1.2. Statement of the Problem

As the main economic sector of Ethiopia, agriculture is dependent on rainfall; this problem coupled with the lack of improved inputs and technologies leads the farmers to survive under pressure of food shortage. Now a day, to overcome or alleviate this problem different interventions has been taken off to promoting small scale irrigation development to use the country's surface and ground water as a strategy and constructions are undergone with the participation of irrigation users (Gebremedhin, 2015).

Since Ethiopia is agrarian nation agriculture is the main stay of the economy. The agricultural sector productivity is usually attributed to erratic and insufficient rainfall and drought. Because of this agricultural production faces frequent failure. In order to surpass this problem irrigation is the basic and the only way and it has the potential to stabilize agricultural production and alleviate the impact of insufficient rainfall in Ethiopia. However, the practice of small scale irrigation in Ethiopia was hampered by different reasons including poor water management.

Amhara region is endowed with a potential irrigable land area of 0.6 million hectare (3.9%) out of total land mass of 15.5 million hectare. In addition, it enjoys a considerable potential for surface water harvesting by small-scale dams, river diversions and underground water resources. However, the total area under irrigation amounts only about 76 thousand hectare, this is less than 2% of the total cultivated land in the region (BoWRD, 2005).

In west gojjam zone the only medium scale irrigation scheme supported by the government are commencement of Koga modern dam in Mecha and community initiated diversion of portion of river Abay below Bahir Dar town. Therefore in Yilmanadensa woreda only small scale irrigation is practiced through traditional river diversion, spring, Motor pump and Hand dug well. The government business endowment like Ambassel General Trading and Amhara credit and saving institute (ACSI) which is the prominent lending institutions, are working together and importing a huge number of irrigation motorized water pumps to the woreda (Tilahun and Zeleke, 2013).

Population of Yilmanadensa woreda is growing quickly and this has a negative effect in land holding and other natural resources, man to land ratio has increased significantly which increases the need for small scale irrigation to insure food security. This woreda has adequate

land and water resources combined with labor force, some experience, and emerging infrastructure and market opportunity to support irrigated crop production at commercial scale. However, small scale irrigation practice in the woreda remains at subsistence scale which makes the woreda among the least irrigated district in west gojjam zone.

Some smallholder farmers, in Yilmanadensa woreda are benefited from small scale irrigation using mostly motor pumps and river diversion from the existing rivers like Yezat, Shina, Shigez, Tul and the like. But, it is not surprising to find some households reluctant to use small-scale irrigation and depend on rain fed agriculture alone. However, in spite of the serious problem of the non-utilization of the irrigation scheme, the causes of low involvement of households in small scale irrigation practice and its effects on household farm income are not yet studied in the area

Moreover, studies on factors determining smallholder rural farm households, adoption of small scale irrigation and its effect on income are not extensive. Some of them are Wale Gebrial etal,(2015), Abebe etal,(2011), Edo(2014), Getaneh (2011), Agerie(2016), Rahel (2008). Most of these and other studies focus on technical aspects of irrigation schemes and farm specific impact of small-scale irrigation and very little is known for the socio-economic factors that have implications on irrigation practice.

More importantly, in Yilmanadensa woreda, where this study was conducted, studies are scanty and there are no published works on the factors that determine households, adoption of small-scale irrigation and its effect on farm income. In general, there exists little empirical evidence related to the determinants of farm households, small-scale irrigation practice and its effect on farm income.

In order to fill this knowledge gap it needs to back up with research. Therefore, this study was initiated to assess the determinants of small holder rural farm house holds small scale Irrigation practice and its effects on farm income in the study area and try to answer the following research questions.

- What factors determine households, small scale irrigation practice?
- To what extent small scale irrigation practice affect farm income?

1.3. Objective of the study

1.3.1. General objective

The general objective of the study is to examine the determinants of smallholder farm household's practice of small scale irrigation and its effect on farm income in Yilmana densa woreda of west gojjam zone.

1.3.2. Specific objectives

- To identify the main factors that mediate farm households' small-scale irrigation practice
- To analyze the effect of small scale irrigation practice on farm income

1.4. Significance of the Study

The study will have significant effect on increasing individuals, understanding regarding the factors that influence smallholder farm household's small-scale irrigation practice and its effect on output. The findings of the study can be used by local administrators and NGOs in order to devise interventions and can serve as a source of reliable information for farmers and policy makers regarding the actions that should be undertaken so as to improve households, participation in small-scale irrigation. The study result might also be used as a reference and initiate other researchers who are interested in conducting research works from different perspectives on the field which improve use of small scale irrigation.

1.5. Scope of the Study

The study is undertaken in four kebele administration of Yilmana densa woreda of west gojjam zone. The scope of this study is limited to the assessment of determinants of small holder rural farm households, small-scale irrigation practice and its effect on farm income only by comparing users and non users of irrigation without taking into account other dimensions of small-scale irrigation. In order to evaluate the gathered data effectively the study was conducted in one woreda with four kebeles and emphasized on a limited number of households (178 HHs) only.

1.6. Limitation of the study

Household survey by itself is complex and to get reliable data especially on household land holding, volume of production (output), number of live stock holdings as well as other variables which have close economic and social implications. Since respondents fear to give reliable

information and the data will not be free from error. Since the information was gathered through structured interview schedule, the quality of the information depends on the willingness and knowledge of respondents. However, maximum efforts were taken to gather reliable information by convincing farm households about the objectives of the study.

1.7. Organization of the thesis

This thesis was structured into five chapters. Chapter one is introduction and it covers background of the study, statement of the problem, objectives of the study, hypothesis of the study, significance of study, scope and limitation of study and organization of the thesis. Chapter two provides the literature review, basic concepts and definitions and information on the previous works and empirical findings. Chapter three presents methodology and it include background information on the study area, the data source, sample size and sampling method and model specification. Chapter four delivers the discussions, estimation of results and interpretation of descriptive and econometric analysis. Finally, conclusions and recommendations were presented in chapter five.

CHAPTER TWO: LITERATURE REVIEW

This part reviews the concepts and definitions of a household irrigation and its classification with irrigation role in agriculture development, empirical evidences on the determinants of small scale irrigation practice and its effects on farm income

2.1. Basic Concepts and Definitions

Irrigation : is defined as the artificial application of water for the cultivation of crops, trees, grasses etc to arid land. A crop requires certain amount of water throughout its period of growth. So that Irrigation is required at dry and last rainy seasons. During dry period irrigation give important role in order to produce food crops and cash crops. At last rainy period(2016/17) as Ethiopian situation especially some parts of Amhara region rainfall starts late and ends early, so in order to supplement the crop production irrigation provides a greatest role in order to produce more yield.

Irrigation is simply a continuous and reliable water supply to the different crops in accordance with their different need. When sufficient water does not become available the total crop yield becomes lesser, consequently famine and disasters exists in the country, and irrigation can, thus, save from such disasters (Awulachew etal 2005).

Small-scale irrigation: is irrigation, usually on small plots, in which small farmers have the controlling influence, using a level of technology which they can operate and maintain effectively. De Lange(1997) defines small scale irrigation (SSI) as the development of traditional irrigation systems, which are used as complement to rain-fed crop production involving predominantly horticultural crops. Small-scale irrigation is, therefore, farmer managed in which farmers must be involved in the design, process and with decisions about boundaries, the layout of the canals, and the position of outlets and bridges.

Smallholder: The conventional meaning of a smallholder is the condition when the land available for a farmer is very limited (Chamberlin, 2008 and Hazell et al., 2007). The meaning goes far beyond this conventional definition and consists of some general characteristics that the so called smallholders generally exhibit. Chamberlin has identified four themes on the basis of which smallholders can be differentiated one from the others. These include landholding size,

wealth, market orientation, and level of vulnerability to risk (Chamberlin, 2008). Hence, the smallholder is the one with limited land availability, poor resource endowments, subsistence oriented and highly vulnerable to risk. Even so, the smallholder may or may not exhibit all these dimensions of smallness simultaneously.

There is no clearly stated definition as to what constitutes a small farm in Ethiopia and in many developing countries. However, it is well known that "small farmers in Ethiopia constitute most of the Ethiopian population and the food grain production" (Betre, 2006). In Ethiopia, smallholder farmers cultivate about 95% of the total cropped land and produce more than 90% of the total agricultural products (CSA2007). The smallholders in Ethiopia are known for their resource constraints such as capital, inputs and technology; they are heavily dependent on household labor; their subsistence orientation; and their exposure to risk such as reduced yields and crop failure (Betre, 2006; Mahelet, 2007).

Household: Callens and Seiffert (2003) defined household as people living together under the same roof and eating food from the same pot and headed by a household head. The household head may a man or a woman. Increasingly, grandparents are taking up as ahead, as well as adolescents, in those households where both parents have passed away. Within the head of the household, there may be a spouse, children and permanent dependants like elderly parents or temporary dependants like a divorced daughter.

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

Woreda: is an administrative unit that constitutes different kebele and it is equivalent to district.

Kebele: it is the lowest administrative unit in some rural area.

2.2. Theoretical Literature Review

2.2.1. General overview of Irrigation Development in Ethiopia

Irrigation is one means by which agricultural production can be increased to meet the growing food demands of the fast growing population of the country. Increasing food demand can be met in one or a combination of three ways: increasing agricultural yield, increasing the area of

arable land, and Increasing cropping intensity by growing two or three crops per year using irrigation.

Increasing yields under both rain fed and irrigated agricultural systems and increasing crop intensity in irrigated areas through various methods and technologies are the most viable options for achieving food security in the shortest time span. The problems of crop failures, due to droughts and erratic rainfall are common events in the rural settlings of Ethiopia (MOA, 2011).

Although traditional irrigation has been practiced in the highlands for centuries, particularly for producing subsistence food crops, it was only in the early 1950s that modern irrigation technologies were introduced to Ethiopia by a Dutch company in the Upper Awash Valley with the objective of producing industrial crops such as large-scale sugarcane plantations. Most of the irrigated land is supplied from surface water sources, while ground water use has just been started on pilot basis in East Amhara.

Despite, the efforts of the government made to expand irrigation, the country has not yet achieved sufficient of its aspirations in the sub-sector to overcome the problems of food insecurity or curb the situation of rural poverty. According to MOA report the following could be cited as the major constraints impeding development in the irrigation sub-sector:

- predominantly primitive nature of the overall existing production system,
- shortage of adequate agricultural inputs and limited improved irrigation technologies,
- Limited trained human power,
- inadequate extension services, and
- Heavy capital requirement.

Irrigation development, particularly in the peasant-sector has significant importance to raise production and productivity to achieve food self-sufficiency and ensure food security at national level in general and household level in particular. The irrigated agriculture can also play a vital role in supplying sufficient amounts of raw materials at the required quality standards for domestic agro-industries and also increase export earnings. Therefore, considering the importance of the irrigation sub-sector in the overall growth of the agriculture sector, the Government of Ethiopia is giving special emphasis to enhance irrigation. (MOA, 2011)

Irrigation is low on the past regime due to lack of fund, data on different factors of natural resources, infrastructure, skill, research and suitable policy and political options of the region. For much of the lifetime of the Derg regime, very little attention was paid to small-scale and traditional irrigation schemes constructed and managed by peasant farmers. With the nationalization of different enterprises, the government's emphasis was to promote high technology water development schemes managed by state controlled agro-industrial and agricultural enterprises. It was only in the second half of the 1980s, as a result of devastating famine of 1984/85 that the regime began to show interest in small-scale water management schemes. The establishment of the Irrigation Development Department (IDD) within ministry of agriculture (MoA) at the end of 1984, a body entrusted with the development of small-scale irrigation projects, signaled a new approach to water development by the military regime. Even if progress was slow, from the mid 1980s to 1991, IDD was able to construct some small schemes, of which nearly one-third was formerly traditional schemes used by peasants (MoA, 1993)

Small-scale irrigation development was carried out by the surface water division of the Soil and Water Conservation Department (SWCD) of the Ministry of Agriculture (MoA) in that period. In 1984, the division was separated from SWCD and upgraded to Irrigation Development Department (IDD). In 1987, the activities of MOA were being decentralized to zonal offices. In 1992, a new Ministry of Natural Resources Development and Environmental Protection (MNRDEP) was established, with the responsibility for soil and water conservation, rural water supply and sanitation. Although the Ministry retained responsibility for providing agricultural support services, the IDD responsibilities were transferred to regional Natural Resources Bureau. In August 1995, MNRDEP was dissolved and its responsibilities were shared between MoA and the Ministry of Water Resources (MoWR). Within the new arrangements, responsibility for irrigation development was given to the Bureau of Water, Minerals, and Energy Resources Development (BWMERD) while MoWR has an overall policy, planning and regulatory role in respect to water resource development (JICA and OIDA, 2001).

2.2.2. Ethiopian water potential for Irrigation Development

In addition to surface water Ethiopia has an estimated 2.6 billion meter cube of usable ground water potential. Estimates showed that there is sufficient water in the country to develop about

4.5 million hectares of which only about 0.16 million hectares is actually irrigated land under full irrigation in Ethiopia (MoWE, 2011). Irrigated agriculture has realized only 5% of its estimated potential and in terms of output it accounts for approximately 3% of the total food crop production (MOFED, 2007).

Little information exists on the extent to which the so far developed irrigation schemes have been effective in meeting their stated objectives by improving their household's income attaining food self-sufficiency and eradicating poverty (Abonesh et al., 2006). Currently the government is giving more emphasis to the small-scale sector by way of enhancing the food security situation in the country. Efforts are being made to involve farmers progressively in various aspects of small-scale irrigation systems, starting from planning, implementation and management aspects, particularly, in water distribution and operation and maintenance to improve the performance of irrigation.

2.2.3. Socio economic impact of small-scale irrigation

Small scale Irrigation development aims to bring about increased agricultural production and consequently to improve the economic and social well being of the rural population. Properly implemented smallholder irrigation with appropriate technologies may have a considerable potential in improving rural livelihoods, although the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara et al. 2002).

Given the complex set of constraints facing smallholder producers, providing access to irrigation water by itself is not enough; smallholders also require a broad range of support services like access to inputs, credit, output markets, and knowledge of farming. Achieving economic viability of smallholder irrigation on a market-oriented basis requires access to support services and opportunities for producing high value crops. The issue of smallholder irrigation expansion should focus on institutional linkages, access to markets and other support services that enhance production on a sustainable basis in addition to providing irrigation water and land.

There are strong direct and indirect linkages between small scale irrigation and poverty (Hussain and Hanjira, 2004). Direct linkages operate through localized and household level

effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Irrigation practice benefits the poor though higher production, higher yields, lower risk of crop failure, and higher and year round farm and non-farm employment. It enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production. Past interventions in irrigated agriculture in Africa have yielded immense benefits. For example, In central Ethiopia, Fuad (2001), shows that many of the people who have been regular beneficiaries of periodic cash crop production using irrigation are now more income secured and have better access to food.

Gebremedhin B. and D Pedon (2000) stated that in Ethiopia, most problems of small-scale irrigated agriculture that hinder the further development of this sector arise from its operational method and not from its construction and design. He pointed out that irrigation development planning gave emphasis to the agronomic, engineering and technical aspects of water projects, with little consideration to issues of management, beneficiary participation, availability of institutional support services such as credit, extension and input supply, and marketing.

He farther stated that the experience of irrigation water development in the last five decades in Ethiopia suggest that several measures need to be taken to support farmer-managed small-scale irrigation projects in Ethiopia. These include: Enhancing and improving the efficiency of the traditional irrigation systems such as: Improving the durability of headworks, Making simple, cheap and environmentally friendly irrigation technologies such as hand pumps and shallow tube wells available, Improving market access by building roads, price support and improving product quality, Developing appropriate extension and credit services, and input supply system, Enhancing beneficiary participation in governance (establishment of working rules and responsibilities) and management (running the day-to-day operation of projects).

Mintesinot (2002) indicated that irrigation compounded with rain fed cultivation ensures year round food security, although, off-farm employment during part of the year is a common practice to obtain extra money.

2.2.4. Challenges and Opportunities of small scale Irrigation in Ethiopia

The main challenges and opportunities for the development of small scale irrigation in Ethiopia According to the MoWIE, (2013) and MoA, (2011) are listed as follows:

2.2.4.1. Challenges of small scale irrigation

The technical constraints and knowledge gaps are identified as challenges of small scale irrigation and discussed here under:

Inadequate awareness of irrigation water management as in irrigation scheduling techniques, water saving irrigation technologies, water measurement techniques, operation and maintenance of irrigation facilities, Inadequate knowledge on improved and diversified irrigation agronomic practices, Shortage of basic technical knowledge on irrigation pumps, drip irrigation system, sprinkler irrigations, surface and spate irrigation methods, Scheme based approach rather than area based approach for the development of SSI Schemes, Inadequate baseline data and information on the development of water resources, Lack of experience in design, construction and supervision of quality irrigation projects, Low productivity of existing irrigation schemes, Inadequate community involvement and consultation in scheme planning, construction and implementation of irrigation development and Poor economic background of users for irrigation infrastructure development, to access irrigation technologies and agricultural inputs, where the price increment is not affordable to farmers.

2.2.4.2. Opportunities of small scale irrigation

The basic opportunistic considerations regarding irrigation developments in Ethiopia are:

Emphasis and priorities are given to irrigation in the growth and transformation plan of the country, Indigenous knowledge and introduction of promising household water harvesting and micro-irrigation technologies, Government's strong political commitment and encouragement to private sector and public enterprises involvement in irrigation development, Abundant water resources, climate and land suitability, Availability of inexpensive labour and Availability of suitable lands for irrigation developments especially at arid areas of the country.

2.2.5. Key Constraints of Small Scale irrigation Development in Ethiopia

Although, Ethiopia is considered as a water tower of Africa, only 5% irrigation potential is developed yet (Adugna, 2014). Small scale irrigation can increase security of crop production and income earning, although there are several constraints on the performance of small scale

irrigation schemes and most are not performing at the best of their capacity. According to him the key constraints impeding the success of small scale irrigation are:

Poor scheme management: Many of the small scale irrigations schemes were under severe challenges of siltation and sedimentation. Since Inefficient erosion drainage systems along the canals has caused severe siltation problem. The community has been forced to invest their scarce labor at peak periods for removing siltation at least three times a year. Other aspect of poor scheme management is inadequate and late maintenance of canals.

Imperfect market: All over the rural areas of Ethiopia; market access and marketing facilities are the major constraint influencing farmers, success in small scale irrigation. There is no rational place or customer for selling their products. Since the middlemen and brokers were exploiting their benefit

Insufficient technical skill: Low capacity of farmers, lack of know-how in opportunities of irrigation technology; weak economic base and the relatively high development costs involved in developing irrigation schemes are also the other key constraints in many parts of the country; the farmers are practicing irrigation without essential know-how on crop water need, water application method and irrigation interval.

Socio-institutional constraints: there exists low institutional capacity which is critical to enhance development of small scale irrigation with respect to development planning, design, implementation, and operation and maintenance including irrigation advisory services, limited or no priority given to irrigation development during national and local planning and budgeting, poor management structures in place to support farmers and promote irrigation development.

Financial shortages: Lack of long and short-term credit provision affects the production of the small scale irrigation scheme.

2.2.6. Classification of Irrigation Developments in Ethiopia

Based on the Ministry of Water Resource (2002), irrigation systems in Ethiopia are classified using two systems. The first classification system uses the size of command area irrigated and it is classified as follows:

Small-Scale irrigation (SSI): are those covering an irrigated area of less than 200 hectare and growing primarily subsistence crops. Small-scale irrigation systems serve mainly to supplement rainfall and provide a greater degree of security to peasant farmers (Girma, 2003). Examples of SSIs include household-based RWH, hand-dug wells, shallow wells, flooding, household-based river diversions, pumping and other traditional methods.

Medium scale irrigations (MSI): are those extending between 200-3000 hectares and produce a mix of subsistence cash crops.

Large-scale irrigation (LSI): are those extending from 3000 hectares and above which are growing primarily commercial crops such as cotton and sugar cane and mainly managed by the state corporations.

The second classification uses a mix of the history of establishment, time of establishment, management system and nature of the structures. Based on this irrigation schemes are classified as follows:

Traditional schemes: are SSI systems which usually use diversion weirs made from local material which need annual reconstruction. The canals are usually earthen and the irrigations are managed by the community. Many are constructed by local community effort and have been functional for long periods of time; some were recently constructed with the aid of NGOs and government.

Modern schemes: are SSI systems with more permanent diversion weirs made from concrete hence no need for annual reconstruction. The primary and occasionally secondary canals are made of concrete and they are community managed and have recently been constructed by government.

Public schemes: These are large scale operations constructed and managed by the government. Sometimes, public schemes have out growers whose operations are partially supported by the large scheme.

Private: These are privately owned systems that are highly intensive operations.

2.3. Empirical literature review

A study conducted by (Asayehegn etal, 2011) Effect of small-scale irrigation on the income of rural farm households: The case of Laelay Maichew District, Central Tigray, Ethiopia, indicated that income, gender, access to market information and health condition of households were found to be important determinants for participation in small scale irrigation schemes. According to himimproving rural farm households, access to market information and health services, are likely to improve participation in irrigation schemes thereby improving small holder farmers, income.

According to (Adugna etal, 2014), conducted on the title, €The role of small scale irrigation in poverty reduction•, irrigation improved household income and contributed to poverty reduction. They reported that the enhanced poverty impact of irrigation was constrained due to unsatisfactory performance and imperfect market. By using binomial logit model on 313 sample households from the Rift Valley Lake Basins, they argues that enhancing the capacity of water user associations through provision of training, market linkage and finance are a necessary step to improve irrigation performance towards poverty reduction.

(Woldegebrial, 2015), using propensity score matching on €adoption of small-scale irrigation and its livelihood impacts in northern Ethiopia• confirm the presence of a statistically significant difference in income, overall expenditure, asset accumulation and expenditures on agricultural inputs between the treated and control households. In contrast he concludes that no statistically significant differences in livestock resources, food consumption, and expenditure on education and health were found. overall he concluded that participation in the small-scale irrigation has robust and positive effect on most of the livelihood indices and that an expansion of irrigation schemes is a good strategy in the water-stressed and drought-prone areas of Ethiopia.

(Dr. P.Madhu and Nahusenay, 2015) examines the challenges and opportunities of small-scale irrigation schemes in northern Ethiopia, with the view of strengthening their significance in improving rural livelihoods in Tigray region by taking total of 100 respondents from three woreda. They found that factors such as investment and construction of ponds, investment in purchase of inputs, investment in purchase of pumps, total irrigated land in ha and revenue from agricultural products are playing an important role in promoting agricultural production and there is positive and significant relationship to agricultural production. They also identified that

the problems of small scale irrigations as shortage of agricultural inputs specially improved seed and pesticides, financial constraints especially for the purchase of motor pumps, high cost of irrigation, shortage of water pump technologies, spare parts and tools, technical problems such as maintenance of motor pumps, insufficient market information and market networks, shortage of ponds and diversion, infrastructure specially road and storage, theft of fruits, diseases and pests.

(Aseyehegn etal, 2012) revealed that income, gender, access to market information and health condition of households are important determinants for participating in small scale irrigation schemes. The result further revealed that irrigation participation, family labor force, livestock ownership and access to market information and credit are positively and significantly associated with household income. Hence, improving rural farm households, access to market information and health services, is likely to improve participation in irrigation thereby improve small holder farmers income.

(Abdi, 2015) analyze determinants of agro pastoralists, participation in irrigation scheme: the case of fentalle agro pastoral district, oromia regional state, Ethiopia using descriptive statistics and logistic regression. He found that agro pastoralists do have medium to very strong perception towards different aspects of irrigation performance indicator variable. According to him among the variables in logistic regression, age, sex, income, input use and participation in cooperative organization have affected participation significantly and positively, while, farm experience, distance to the district market, and total livestock unit, affected participation in irrigation significantly and negatively.

According to (Abebaw etal, 2015), total income of the household, conflict over irrigation water utilization, training and technical advice, education status of household head, farm size, financial constraint, proportion of irrigated land size, and access to market information are statistically significant. poor technology choice, conflicts in water use and use rights, lack of market access, lack of training on irrigation technologies, lack of irrigation structure maintenance, absence of government support, and poor linkage between research and extension services in the area of irrigation water management and development were constraints of irrigation forwarded by the participants.

A study by (Rehima etal, 2013) on Analysis of the Determinants of Small Scale Farmers, Grain Market Participations in Ethiopia: The Contribution of Transaction Costs indicated that

demographic characteristics of the households (age and dependency ratio), production assets (own and rented in land and oxen), land characteristics, volume of production, and households income diversification (livestock and non-farm income) affected both sellers and buyers.

(Dereje and Desale, 2018) takes a total of 374 respondents and they analyzed the collected data by descriptive statistics. They found that the application of SSI improved the annual income of irrigator households from 1978.12 to 10,099 Ethiopian Birr before and after using irrigation with a standard deviation of 1534.32 compared to non-irrigators who have an annual average income of 3146.75 ETB with a standard deviation of 1838, respectively. It proved that 32.1% of irrigators increased their frequency of production due to irrigation. Shortage of water, access to improved seeds, marketing, and increment of farm input costs have been hindering SSI practices. They conclude that awareness campaigns for irrigators and adequate supervision for the irrigators by development agents (DAs) and district officials are important to improve the livelihood of farmers.

A study by (Mensah and Adebayo, 2014) on the analysis of the factors influencing farmers, decisions to adopt low-cost small motor pumps based on a survey of 800 farm households in four regions of Ethiopia. They found that gender; age; ownership of, or access to extension; access to surface and shallow ground water; social capital and regional differences captured by a regional dummy, all influence farmers, decision of motor pump adoption.
(Beyanet al, 2014) assess Impact of Small-scale Irrigation on Farm Income Generation and Food Security Status: The Case of lowland Areas, Oromia, Ethiopia. The logistic regression estimation revealed that educational level of household head, cultivated area, social status, livestock holding, oxen owned and irrigation distance significantly affected the participation decision of households in irrigation. The results revealed that households that participate in irrigation practice have got an improvement of 34 percent and 48 percent in calorie intake and farm income than those households that were not participated respectively, which shows participation has a significant, positive and robust impact on the outcome variables.

A study by (Tsegazeab and Dr. Surajit, 2016) on The Impact of Small Scale Irrigation on Household Income in Bambasi Woreda, Benishangul-Gumuz Region, Ethiopia. Estimates of

the propensity score matching of the probit model exhibits that gender, the linear and non linear age, education, plot size, social position participation, extension service, access to credit and total livestock unit are the statistically significant variables which significantly affects the income of small scale irrigation.

According to (Tsehay Yu and Professor Krish, 2013) Challenges in farmer-managed small-scale irrigation schemes: Case study on South Achefer Woreda of Amhara region, Ethiopia revealed that the performance of the irrigation users, cooperative in managing the scheme found at low levels show a wide gap between the objective and actual implementation. Factors that were found to be significant are poor enforcement of rules and regulations, existence of water rights, limited membership which makes the implementation of collective action difficult, poor external support from the respective stakeholders, and the multifunctional nature of the organization which causes leaders not to focus on the core objectives of water management activities.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Description of the Study Area

Yilmana Densa is one of the woreda with 33 kebeles in the Amhara Region of Ethiopia Part of the west Gojjam Zone which is bordered on the south by Kuarit, on the southwest by Gekela, on the west by Mecha, on the north by Bahir Dar Zuria, on the east by the Abay River which separates it from the south Gondar Zone, and on the southeast by the east Gojjam Zone The major town in Yilmana Densa woreda is Adet. The study was carried out in this woreda, geographically located between 11° 14' 30"- 11° 20' 30" N latitude and 37° 20' 30"- 37° 52' 30" E longitudes.

Fig3.1: location map of Yilmanadensa woreda

The study area is found on an average altitude of about 2220 meter above sea level. Agro ecologically, it isclassified as Weina Dega climatic zone. The annual rainfall ranges from 860 to 1771 mm, whereas the annual temperature ranges from 8.80 to 25.40 ^{0}C with mean value of 17.1^{0}C.The area receives a bimodal rainfall where the small rains are occurred between Mar and May (Belg) while the main rains occur during July to September.

The major land use types in the study area include arable land, grazing land and medium forest land. The present land use of the area is dominated by more traditional peasant farming on individual household holdings of the farm land. The total farming system of this area is strongly orientated towards grain production of teff, garlic, maize and potato and of minor cash crops such as peppers.

In west gojjam zone the only medium scale irrigation scheme supported by the government are commencement of Koga modern dam in Mecha and community initiated diversion of portion of river Abay below Bahir Dar town. Therefore Yilmanadensa is among the least irrigation potential district in west gojjam zone. In the woreda only small scale irrigation is practiced through traditional river diversion, spring, Motor pump, Hand dug well and others. The government business endowment like Ambassel General Trading and ACSI, the prominent lending institutions, are working together and importing a huge number of irrigation motorized water pumps to the woreda. Main interventions taken in the woreda includes awareness creation and capacity building to farmers, provision of planting materials, improved extension support, water harvesting technology, efficient water management including strengthened water user associations, and market linkages (Tsehun and Zeleke (2013) and DOID,(2017)).

3.2. Data Source and Data Collection Methods

For the better accomplishment of the study both primary and secondary data sources were gathered and analyzed to collect both quantitative and qualitative data. The conventional household survey was the main method used to collect primary information through a carefully designed structured interview schedule which was prepared for the study to get information pertaining to households, demographic, socio economic characteristics and institutional situations. Two enumerators in each sample kebeles were employed to conduct the survey under the close supervision of the researcher. The enumerators were selected based on their knowledge and acceptance among the community and ability to speak local language, which

helps the researcher to get properly filled questionnaire. Appropriate training was given to the enumerators to enhance their understanding regarding the objectives of the study, the content of the questionnaire, how to approach the respondents and conduct the interview. In addition to primary data, secondary data that could supplement the primary data was collected from published and unpublished documents, District and Zonal Offices of Irrigation Development (OID), District and Zonal Offices of Agricultural and Rural Development (OARD).

3.3. Sample Size and Sampling Method

In this study, two stage sampling procedure was adopted for the selection of sample respondents. In the first stage, out of 33 rural kebeles that are found in Yilmana Densa woreda four kebeles namely Adet zuria, Gosheye, Gube and Diwar were selected based on the basis of their irrigation potentials and availability of information. In the second stage, first the household heads in the four sample kebeles were identified and stratified in to two strata: irrigation user and non user. Then non-users were selected within Kebeles of irrigation users to ensure homogeneity of factors except irrigation

Based on the equation developed by Cochran (1975) to select a representative for proportions of large sample the formula is given by:

$n_0 = Z^2 p q / e^2$ ..... (1)

Where

n_0 is the sample size

Z^2 is the abscissa of the normal curve that cuts off an area … at the tails (1 – … equals the desired confidence level which is 95%),

e is the desired level of precision which is 0.05

p is the estimated proportion of an attribute that is present in the population, and q is 1 – p

The value for Z is found in statistical tables which contain the area under the normal curve. Based on this formula a total sample of 178 rural households, 92 households from irrigation non-user and 86 irrigation user households have been drawn by taking in to account probability proportional to sample size, since the number of household heads in the four Kebele administrations was not proportional. Then after the sample respondents from each stratum was selected using simple random sampling technique.

Table 3.1 shows that the total population of each sample Kebele, users and non-users of irrigation and the samples selected from each Kebele.

Table 3.1: Distribution of sampled households in the study area

Kebele	Total population	Users	Sample	Non users	Sample
Adet zuria	1682	720	24	962	32
Diwaro	870	323	10	547	17
Gosheye	2063	1137	36	926	30
Gube	917	510	16	407	13
Total	5532	2690	86	2842	92

Source: own computation, (2017)

3.4. Methods of Data Analysis

The study used both descriptive and econometric data analysis techniques. In descriptive statistics the demographic and socioeconomic behavior of household characteristics were explained and in econometric analysis the determinants of smallholder farm household practice of small scale irrigation and its effect on income was analyzed by using STATA software package. Since STATA is powerful statistical software that enables us to analyze, manage, produce graphical visualizations of data in addition to mathematical analysis

3.4.1. Descriptive Statistics

Descriptive statistics is one of the techniques used to summarize data collected from a sample. It was employed to explain the demographic and socioeconomic behavior of household characteristics. By applying descriptive statistics such as mean, standard deviation, frequency of appearance, percentage etc, we were compare and contrast different categories of sample households with respect to the desired characters so as to draw some important conclusions for the total population. Moreover, t-test and chi-square test were used to compare irrigation users and non-users in terms of different explanatory variables. Therefore this study can be analyzed joint frequency distribution with the chi square statistic (χ^2) to determine whether the variables are statistically independent or if they are associated.

3.4.2. Econometric Model

Regression models in which the regressand takes a yes or no or present or absent response are known as dichotomous or dummy dependent variable regression models. They are applicable in a wide variety of fields and are used extensively in survey or cross-sectional data (Gujarati, 2004; Woodridge, 2002). The dependent variable in this study is also a dummy variable, which takes a value of zero or one depending on whether or not the household uses small-scale irrigation. Small-scale irrigation practice is a dependent variable, which is dichotomous taking on two values, one if the household uses small-scale irrigation and zero otherwise. Estimation of this type of relationship requires the use of qualitative response models. In this regard, the non-linear probability models, logit and probit models are the possible alternatives. However, several estimation problems arise particularly when Ordinary Least Squares (OLS) regression and linear probability models are employed (Gujarati 2004).

The OLS regression technique when the dependent variable is binary, produces parameter estimates that are inefficient and a heteroscedastic error. Consequently, hypothesis testing and construction of confidence interval become inaccurate and misleading. Likewise, linear probability model assumes that the probability of an individual making a given choice is a linear function of the individual attributes. But this model has some econometric problems associated with it such as non normality of the disturbance term (u_i), heteroscedasticity of the disturbance term (u_i), the generally lower R^2 values that raises question on the Value as a measure of goodness of fit and possibility of estimated Y_i lying outside the 0-1 range which violates one of the basic tenets of probability (Non fulfilment of $0 \leq E(Y_i/X_i) \leq 1$). The fundamental problem with the LPM is that it is not logically a very attractive model because it assumes that $P_i = E(Y = 1 | X)$ increases linearly with X, that is, the marginal or incremental effect of X remains constant throughout and this seems evidently unrealistic. To alleviate these problems and produce relevant empirical outcomes, the most widely used qualitative response models are the logit and probit models. Therefore, what we need is a probability model that has these two features:

(1) As X_i increases, $P_i = E(Y = 1 | X)$ increases but never steps outside the 0-1 interval, and

(2) The relationship between P_i and X_i is nonlinear (Gujarati 2004).

Two of the most popular alternatives are the probit and logit estimators. Both are maximum likelihood estimators which involve slightly different distributional assumptions, but should

produce roughly the same results. These two binary outcome models have an S-shaped relationship between the independent variables and the probability of an event which addresses the problem with functional form in the linear probability model (Long, 1997).

The probit probability model is associated with the cumulative normal probability function, whereas, the logit model assumes cumulative logistic probability distribution are very close to each other, except at the tails, we are not likely to get very different results using the logit or the probit model. Therefore choice between the logit and probit models revolves around practical concerns such as the availability and flexibility of computer programs, personal preference, experience and other facilities because the substantive results are generally indistinguishable (Maddala, 1983). Therefore, given the similarity between the two models, it is possible to use probit model for the analysis of the determinants of small scale irrigation practice and Heckman two stage model were employed to examine the effects of small scale irrigation on farm income

3.4.2.1. Heckman two-stage Procedure

This method assumes that missing values of the dependent variable imply that the dependent variable is unobserved (not selected). Thus, it is a good way of predicting the value of the dependent variable that would be observed in the absence of selection. If a data set specifies a binary variable that identifies the observations for which the dependent is observed or not, it is much convenient to run this model.

Since the aim of this study is also to analyze the effect of small scale irrigation on farm income, evaluating the effect of small scale irrigation income using regression analysis can lead to biased estimate since OLS model does not take care of the selection bias that may arise due to self selectivity of households to the irrigation scheme and due to unobservable nature of the dependent variable for some observations (Heckman, 1979).

The reason behind is that, the effect of small scale irrigation may be over (under) estimated if small scale irrigation users are more (less) able due to certain unobservable characteristics i.e. if output produced by the household of the irrigation user is significantly higher than that of non users we can not necessarily attribute this difference to the effect of the irrigation program because of the self selectivity component that should be taken care of.

Application of the classical linear regression model in such a case does not guarantee consistent and unbiased estimates of the parameter. One basic solution to this problem in econometrics is the application of Heckman two-stage procedures. It is considered as an appropriate tool to test and control for sample selection biases (Wooldridge, 2002).

In our estimation the Heckman two stage selection model was employed. Since, it considers for selection bias that could arises due to unobservable factors for some respondents. In the first stage, estimate the selection or participation equation (the probability use of small scale irrigation) by using probit model and derives maximum likelihood estimates with data from both users and non-users of the small scale irrigation, using the estimation result "Inverse Mills ratio" is constructed. The constructed inverse Mills ratio (lambda) is the tool for controlling bias due to sample selection (Heckman, 1979). The second stage involves including the Inverse Mills ratio as an explanatory variable to the household output equation and estimating the equation using OLS model using data from user households only.

If the coefficient of the selectivity, term is significant then the hypothesis that the irrigation practice equation is governed by unobserved selection is confirmed. In addition with the inclusion of extra term, the coefficient in the second stage selectivity corrected, regression is unbiased (Zaman, 2001). Therefore, we are interested to apply Heckman two stages model for this study.

3.4.2.2. Specification of the Econometric Model for irrigation practice equation

In order to fulfill the desired objectives the following functional form is used.

$P_i = f(Z_1, Z_2, Z_3, Z_4, \ldots Z_n)$ ..... (3)

The econometric equation for the probit model stated in equation (3) can be specified as:

$P_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \ldots + \alpha_n Z_n + \varepsilon_i$ ..... (4)

Where,

Pi = dichotomous variable representing use of small-scale irrigation; and it is equal to one if the household practice small scale irrigation and zero otherwise.

Z1, Z2, Z3 ...Zn is the vector of variables that affect smallholder farm households, decision to use small scale irrigation.

Parameters; α_1, α_2, α_3 & .. represents coefficients for the row vectors to be estimated, and ε_i is the error term.

3.4.2.3. Specification of the Econometric Model for output equation

3.4.2.3.1. Specification of Heckman two-stage Model

The small scale irrigation output equation is presented as:

$$= \quad + \quad \text{,,,,,,,,,,,,,,,,,,,,} \quad (5)$$

Where

Yi is the individual income from small scale irrigation, it is observable for the users and unobservable for the non-user households that is why we use Heckman sample selection.

Xi is a vector of observable factors that affect the level of income from small-scale irrigation and

is the error term.

The selection model for household's practice of small scale irrigation is explained by the equation stated below and it indicates that household's practice of small scale irrigation depends on some value pi* of a latent variable.

$$" = \quad + \quad \text{,,,,,,,,,,,,,,,,,,,,,,,,} \quad (6)$$

Thus, we can determine the practice of irrigation and small-scale irrigation income from the selection equation as stated below.

$$Pi = \begin{cases} 1 \text{ if } pi^* > 0 \\ 0 \text{ if } pi^* < 0 \end{cases}$$

The decision to practice small scale irrigation is given by pi=1 and the decision not to practice is pi=0.

Where

pi is a variable indicates practice of small-scale irrigation,

Z is a vector of variables that affect household's use of irrigation and

‡i is the corresponding error term.

The output equation from small scale irrigation is explained as:

$$= \begin{cases} + & \text{If } pi^*>0 \\ \text{Unobservable if } pi^*<0 \end{cases}$$

The error terms (‡i and Ei are assumed to follow a bivariate normal distribution with mean 0, variances ‡ a n d respectively, and correlation coefficient. The other assumption is the error terms (ˆ‚‡) are independent of both sets of explanatory variables X and Z.

The conditional expected output of individual households who use small scale irrigation becomes:

$$(\quad / \quad = 1) = \quad + \quad (\quad / \quad = 1)$$

$$= \quad + \frac{" \ (\quad)}{‰(\quad)}$$

$$= \quad + \quad \text{„„„„„„„„„„„„„„„„„„„„„„„„„„„„.} \ (7)$$

The term" ( )/‰( ) is known as inverse Mill,s ratio; usually represented by lambda (Š) and reflects for the selection variable for selection bias.

Therefore, in our two stage procedure we simultaneously model the decision of small scale irrigation and the effect of the irrigation on household farm income

$$Yi = f(X_1, X_2, X_3, X_4 \ldots X_n) \ \text{„„„„„„„„„„„„„„„„„„„„} \ (8)$$

The econometric equation for the output model stated in equation (8) can be specified as

$$\ln \quad = \quad + \quad 1 \ 1 + \quad 2 \ 2 + \quad 3 \ 3 \ \& \ \& + \quad + \quad Š \ + \ \text{„„„„„„„„„.} \ (9)$$

Where,

lnYi= represents the logarithm of income from small scale irrigation

X_1, X_2, X_3„„„. X $_n$ are determinants of smallholder farm household,s output from small scale irrigation.

Parameters; ‚ B B_1, B_2„.B $_n$ represent coefficients to be estimated, Š is the inverse mills ratio and is the error term

3.5. Definition of Variables and Hypotheses

3.5.1. Dependent variable

In the estimation of the determinants of practice of small-scale irrigation, the dependent variable for the model is use of irrigation. This variable is a dummy variable given a value of 1 if the household practices small scale irrigation and 0 if not. For the Heckman second stage analysis the dependent variable farm income is a continuous variable and it is transformed in to logarithm. Since taking the logarithm of the dependent variable helps us to handle situations where a non-linear relationship exists between the independent and dependent variables and also it is convenient means of transforming a highly skewed variable into one that is more approximately normal.

3.5.2. Explanatory variables

Based on the researcher,s knowledge of the farming system of the study area and review of literatures on factors influencing practice of small scale irrigation and level of farm income, among the large number of factors which are expected to relate to farmers, practice of irrigation and output level, the following potential explanatory variables are hypothesized in this study and examined for their effect.

Distance from the nearest market: It is measured in kilometer. It is the distance to the market to buy input and to sell outputs. As the farmer is nearer to a market, the higher will be the chance of using small-scale irrigation. For perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving to the market. Therefore, distance from market is hypothesized to influence negatively the farmers, decision to practice small-scale irrigation and level of farm income.

Access to market information: It is a dummy variable, which takes 1 if the household has access to information and 0 otherwise. The probability of irrigation practices by household will be high for households having access to market information than households who do not have access to market information. It is, therefore, hypothesized that access to market information has direct relation with practice of irrigation and income level.

Education Level of the household head: Education level of the household head is a dummy variable taking value 1 if the household head is literate or zero otherwise. Literate individuals are very ambitious to get information and use it than illiterate. If the household head is literate he/she will be very prone to accept extension services and participate in irrigation. Previous

studies also revealed that education would influence adoption positively (Adebabay, 2003). As a result it is expected that education has positive relation with the smallholder farmer's practice of irrigation.

Cultivated land size: This refers to the total cultivated land size of a household measured in hectare. As the cultivated land size increases provided other associated production factors remain constant, the likelihood that the holder gets more output is high. Hence farmland is major input for agricultural production in rural households; total cultivated land should have a positive relationship with income of a household (Kamara et al. 2001). As a result it is hypothesized that cultivated land has positive effect on irrigation practice and farm income obtained.

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. It is assumed that male household heads have more exposure and access to information and new interventions than female headed household, which might enable them to participate in the small scale irrigation. With regard to farming experience males are better than the female farmers. Therefore, Male headed households have a better position to use irrigation than the female headed ones. The literature cited in Yami (2005) indicates that female-headed households have less access to improved technologies, land and extension than male headed household. Therefore, it is hypothesized that male headed households have higher level of farm income and they practice irrigation more than female headed households.

Age of the household head: Rural households mostly devote their live time on agriculture. The older the household head, the more experience he/she has in farming. As a measure of experience including the losses associated with failing to adopt technology early, age could have a positive effect on participation (Kenkel & Norris, 1995). In light of this, it is hypothesized that age of the household head is positively related with irrigation practice and income of the household.

Family size: Family is the major source of agricultural labor in rural areas. Households with large family size have more labor for agricultural production than small family size. Previous study reported by Tesfay and Alemu (2001) shows that family size influence adoption of

technology positively. Hence, it is hypothesized that larger family size has positive relation with irrigation practice and level of farm income.

Access to credit facility: This is a dummy variable which takes 1 if the household has access to credit and 0 otherwise. Access to credit is an important source of income. Those households, who have access to credit, have better possibility practice irrigation. Previous research by (Tesfaye and Alemu, 2001) confirmed that access to credit positively influence adoption of technology. Hence, it is expected that, access to credit have a positive relation with the irrigation practice and farm income of households.

Level of soil fertility status (soilfer): It is a dummy variable which takes value of 0 if the land is infertile and 1 if the land is fertile. Here soil fertility is determined based on the response of the surveyed households. If the farm land is fertile the household can produce more and if the land is infertile less will be produced affecting the household income level. Thus, it is expected that households with fertile land have more income than households with infertile land indicating a positive relationship with household income and practice of small scale irrigation.

Access to Irrigation: A dummy variable takes a value of 1 if the household practice small-scale irrigation and 0 otherwise. Irrigation enables farmers to diversify and maximize agricultural production, practice multiple cropping and increasing cropping intensity etc. As a result it is assumed to have a direct relation with the total farm income of a household.

Access to extension service: this variable is a dummy variable, which takes a value of 1 if the household has access to extension service and 0 otherwise. Access to extension service widens the household's knowledge about the use of improved variety and agricultural technologies. Previous study revealed that extension contact has an influence on farm household's adoption of new technology (Nkonya et al., 1997). Therefore, access to extension service is hypothesized to have a positive relation with households, participation in small scale irrigation and output produced.

Total livestock holding (livestock): This is the total number of livestock measured in tropical livestock unit (TLU). A household livestock size in TLU is calculated by multiplying the number of each type of animal by an appropriate conversion factor. Livestock

is important source of income, food and draught power for crop cultivation for the household in Ethiopian. More livestock holding is expected to increase the probability of small scale irrigation practice Therefore, in this study it is hypothesized that higher TLU will have positive influence on the practice of small scale irrigation and level of income

Table 3.2: summary of variables included in the model

Variable	Definition	Type	Hypothesis
DISMKT	Residence distance from the nearest market in K	Continuous	-
FAMSIZE	Family size in number	Continuous	+
AGE	Age of the household head in years	Continuous	+
SEX	Sex of the household head	Dummy	+
EDUC	Education status of household head	Dummy	+
LANSIZE	Cultivated land size in hectar	Continuous	+
ACCCR	Access to credit facility	Dummy	+
ACCEXT	Access to extension service	Dummy	+
ACCMKT	Access to market information	Dummy	+
SOILFER	Perception of soil fertility status	Dummy	+
TRU	Total livestock number in TLU	Continuous	+
OUTPUT	Total farm income in birr	Continuous	+
IRR	Category of households (irrigation user or not)	Dummy	+

CHAPTER FOUR: RESULTS AND DISCUSSIONS

This chapter presents the results and discussions from the descriptive and econometric analysis. The descriptive analysis made use of tools such as mean, percentage, standard deviation and frequency distribution. In addition, the t and chi-square statistics were employed to compare users and non-users group with respect to some explanatory variables. Econometric analysis was carried out to identify the most important factors that affect small-scale irrigation practice and farm income.

4.1. Analysis of descriptive statistics Results

In this study the descriptive statistics was run to observe the distribution of the independent variables. The socio-economic and institutional characteristics of the respondents such as family size, age of the household head, sex of the household head, status of education, cultivated land size, access to market information, livestock holding, total farm income, access to credit, perception about soil fertility, access to extension service and distance from the nearest market of users and non-users of small-scale irrigation were included and examined.

From the total sample respondents interviewed 86 were found to be users of small-scale irrigation while 92 were non-users. These were 51.69 percent of the total sample were none users and the remaining 48.31 percents of the total sample were users of small scale irrigation. The demographic, social and economic characteristics of sample households in the study area are discussed as follow. The variables discussed under this topic were those expected to have certain relations with use of small-scale irrigation.

4.1.1. Sex of the household head

Sample households were composed of both male and female headed households. Gender of the household head is an important variable influencing the decision to practice irrigation. The survey result showed that, 14.61 percent of the sample households are headed by females and the remaining 85.39 percents are headed by male households. As the survey result shows that 5.81 percent of irrigation users are headed by female and the rest 94.19 percent are headed by male and the corresponding figure for non users was 22.83% and 77.17% by female and male household heads respectively. Out of the total female headed households 19.23% are irrigation

users and the remaining 80.77 are non users. The corresponding results for male headed households are 53.29% and 46.71 respectively.

The chi-square test (p=0.001) shows that there is statistically significant difference between those household heads that are the users of irrigation and non users in terms of their sex at 1 percent probability level and this shows male headed households are more likely to be irrigation users than female headed households.

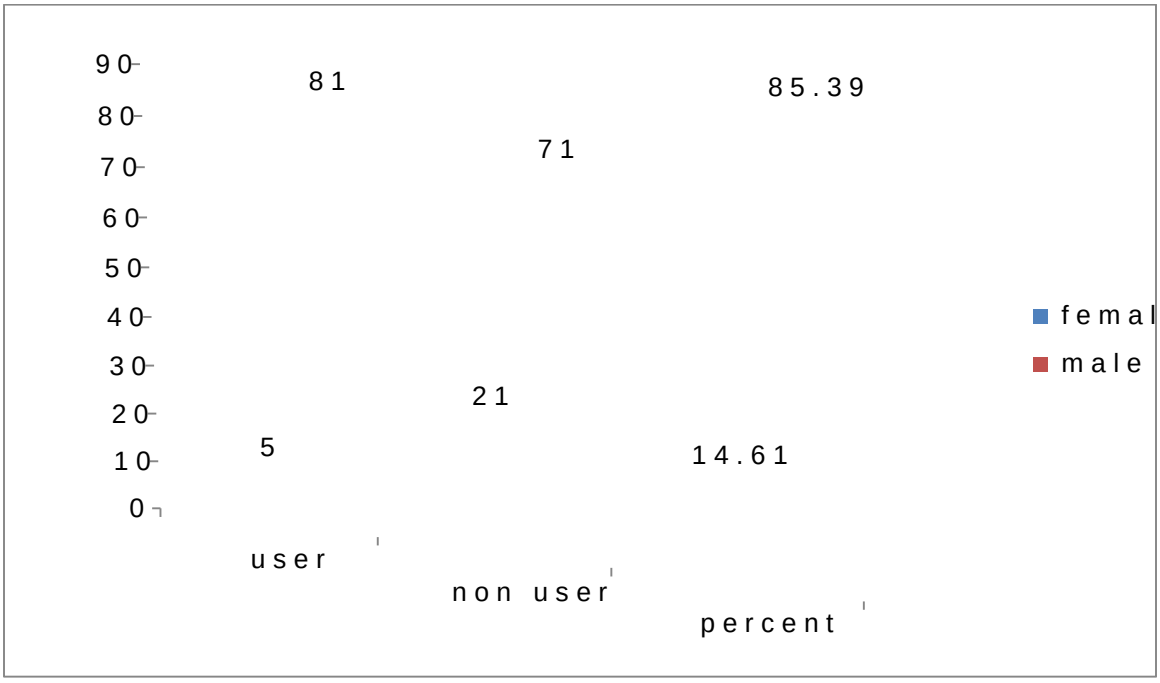

Fig4.1.graphical presentation of sex distribution by Irrigation user and non user

4.1.2. Education status of the household head

Education plays an important role for different household decision. It creates awareness and helps for better achievement of their tasks. The descriptive statistics result showed that of the total sample 82 respondents becomes illiterate and 96 respondents are literate. This shows that 46.07% of the total sample household heads were illiterate where as 53.93% are literate.

The comparison by use of irrigation showed that 21 irrigation users and 61 non-users are found to be illiterate and 65 irrigation users and 31 non-users are literate. From the survey result 24.42 percent of irrigation users and 66.30 percent of irrigation non-users are illiterate and 75.58 percent of users and 33.70 percent of non-users are literate in the study area. The chi-square test (p= 0.000) with Pearson $chi^2(1)$ value of 31.39 shows that there is a significant relationship

between use of irrigation and education status of the household head at 1 percent probability level.

Table 4.1: Distribution of sample household heads by education

Head education status	Users		Non users		Total	
	Number	%	Number	%	Number	%
Literate	65	75.58	31	33.70	96	53.9
Illiterate	21	24.42	61	66.30	82	46.07
Total	86	100	92	100	178	100

Source: computed from own survey data (2017)

4.1.3. Age of the household head

The mean age of the household head of sample respondents in the study area was found to be 48.76 with minimum age of 23 to maximum of 82 years. The average age of users was found to be 47.30 with minimum of 23 and maximum of 75 years. The corresponding result for non users was 50.12 with minimum of 25 and maximum of 82 years. Our t-test statistics the two-sided p-value of 0.15 does not provide strong evidence against the null hypothesis (mean age difference between irrigation users and non users is zero) and therefore we cannot conclude that the mean age of irrigation non users are larger on average than those of users. Since the mean age difference between the two groups is found to be statistically insignificant.

4.1.4. Access to market information

The study result shows that out of the 178 total sample respondents 139 households did not get market information where as the remaining 39 households have access to market information. This indicates that 21.91 percent of the sample households have access to market information and the rest 78.09% of sample have no access to market information. When we compare irrigation user and non user households 96.74% of non users and 58.14% of users have no

market information and 3.26% of non users and 41.86% of irrigation users have access to market information. The chi-square test result with Pearson chi2 value of 38.71 (p=0.000) indicated that there is statistically significant relationship between the practice of irrigation and access to market information at 1 percent probability level.

Table 4.2: Distributions of sample household heads by access to market information

Access to market information	User		Non user		Total	
	Number	%	Number	%	Number	%
Access	36	41.86	3	3.26	39	21.91
No access	50	58.14	89	96.74	139	78.09
Total	86	100	92	100	178	100

Source: computed from own survey data (2017)

4.1.5. Access to credit service

Credit from different sources, is an important institutional service to finance poor farmers for input purchase and ultimately to adopt new technology. However, some farmers have access and utilization to credit while others may not have access to credit service due to problems related to repayment and down payment in order to get input from formal sources. The source of credit in the study area is micro finance institute (Amhara Credit and Saving Institution (ACSI)).

The study result shows that from the total sample household respondents 15.17 percent get credit access while the remaining 84.83 percent do not take credit access due to various reasons. The comparison by access to irrigation indicated that 88.37% users and 81.52% non users did not take credit and the remaining 11.63% of users and 18.48% of non users take credit access. The chi-square test result (p=0.203) revealed that there is no significant relationship between access to credit and practice of irrigation.

4.1.6. Access to extension service

It is widely accepted that agricultural extension services play a pivotal role in the motivation of farmerstowards the adoption of improved irrigation practices. The introduction of high valued crops, efficient use of water and proper use of inputs have all been deemed as significant factors for crop production and productivity (Madhusudan et al. ,2002). Extension service here refers to advice, training, demonstration related to crop and horticultural production. The survey result revealed that 32.02% of the sample respondents get extension service and the remaining 67.98% did not get extension service. The comparison by access to irrigation disclosed that 47.67% of the users and 17.39% of the nonusers get extension service. The chi square test (p=0.000) indicated that there is significant relationship between irrigation practice and access to extension service at 1% level of significance.

Table 4.3.distribution of sample respondents access to extension service

Access to extension service	User		Non user		Total	
	Number	%	Number	%	Number	%
Access	41	47.67	16	17.39	57	32.02
No access	45	52.33	76	82.61	121	67.98
Total	86	100	92	100	178	100

Source: computed from own survey data (2017)

4.1.7. Family size

The average family size of sample respondents was 4.99 individuals with a minimum of 2 and a maximum of 10 individuals per household head. The mean family size for users was found to be 5.08 and for non users were 4.90. The value of 0.68 in the t-test statistics shows that the mean family size difference between irrigation users and non users is found to be statistically insignificant.

4.1.8. Level of soil fertility status

The distribution of total sample respondents in terms of soil fertility status has shown that 45.51% of the sample respondents have fertile land while 54.49% of the total respondents believe that soil fertility of their land was infertile. The comparison between irrigation users and non users revealed that 65.22% of non users and 43.02% users have not fertile land where as 64.13% of non users and 40.70% of users have moderately fertile land and the rest 34.78% of non users and 56.98% of users perceived that their land was fertile. The chi square test (p=0.003) revealed that there is a statistically significant relationship between soil fertility status and the practice of irrigation at 1% level of significance.

Table 4.4: Summary of descriptive statistics for discrete variables by access to irrigation

Variables		Non users (N=92)	User (N=86)	Total sample (N=178)	-value (p-value)
accmkt	access(1)	3(3.26)	36(41.86)	39(21.91)	0.000***
	no access(0)	89(96.74)	50(58.14)	139(78.09)	
educ	literate(1)	31(33.70)	65(75.58)	96(53.93)	0.000***
	illiterate(0)	61(66.30)	21(24.42)	82(46.07)	
acccr	access(1)	17(18.48)	10(11.63)	27(15.17)	0.203
	No access(0)	75(81.52)	76(88.37)	151(84.83)	
accext	access(1)	16(17.39)	41(47.67)	57(32.02)	0.000***
	No access(0)	76(82.61)	45(52.33)	121(67.98)	
soilfer	infertile(0)	60(65.22)	37(43.02)	97(54.49)	0.003***
	Fertile(1)	32(34.78)	49(56.98)	81(45.51)	
sex	male(1)	71(77.17)	81(94.19)	152(85.39)	0.001***
	Femal(0)	21(22.83)	5(5.81)	26(14.61)	

Source: own computation (2017)

Note: *** represent statistically significant at the 1% significance level and numbers in parentheses indicate percentages.

4.1.9. Livestock holding

Farm animals have an important role in rural economy. They are source of draught power, food, such as, milk and meat, cash, animal dung for organic fertilizer and fuel and means of transport. Farm animals in the study area also serve as a measure of wealth in rural area. To help the standardization of the analysis, the livestock number was converted to tropical livestock unit (TLU). The type of agriculture in the study areas are mostly known by settled agriculture with a mixed farming system (i.e. integrated crop and livestock production).

The mean livestock holding in Tropical Livestock Unit (TLU) for the sample household respondents was 4.82, where the minimum is 0.00 and the maximum is 10.85. The mean livestock holding for irrigation user household heads is 4.86 in TLU and mean livestock holding for non-users of irrigation is 4.77 in TLU. The t-test result showed that the mean comparison of the two groups with regard to livestock holding is statistically insignificant.

4.1.10. Distance from the nearest market

The survey result indicated that the average distance of sample respondents from the nearest market place is found to be 2.47 km with a minimum of 1.05 km and a maximum of 10 km. The average for sample households with access to irrigation is 3.02 km while the corresponding figure for the non-user households is 3.89 km. The result shows that the user households have a better access to market. Access to market is a determinant of profitability and sustainability of agricultural production. Respondents in the study area reported that they sold some of their agricultural products right after harvest to cover costs of farm inputs, social obligation and urgent family expenses by taking to the immediate nearby local market. In our t-test statistics the two-sided p-value of 0.0016 provide strong evidence against the null hypothesis (mean difference between irrigation users and non users with regard to distance to the nearest market is zero) and therefore we can conclude that the mean difference between non users and users of irrigation. Since the mean difference between the two groups in terms of distance from the nearest market is found to be statistically significant at 1% level of significance with t-value of 3.21.

Table45. Socio-economic and institutional characteristics of the sample households (continuous variables)

Variables	Observations	Mean	St.devation	Min	Max
age	178	48.76	13.15	23	82
Dismkt	178	3.47	1.86	1.05	10
Tru	178	4.82	1.93	0	10.84
Famsiz	178	4.99	1.74	2	10
Lansiz	178	1.2	0.45	0.25	2.5

Source: computed from own survey (2017)

4.1.11. Cultivated land size

The land holding size of the sample household varies from 0.25 to 2.5 hectares with the average land holding of the sample household head is 1.20 hectare. The mean land holding for users of irrigation is 1.17 hectares and the corresponding figure of land holding for nonusers of irrigation is 1.23 hectares. The t-test revealed that mean difference between the two groups by land holding size is statistically insignificant.

4.1.12. Total crop production

The major crops grown in the study area are maize, teff, wheat, beans, sorghum and horticultural crops such as pepper, onion, tomato etc. The mean annual production of the sample household is 60648.37 birr with a minimum of 4595 birr to a maximum of 241697 birr. The average annual production for irrigation user households was 91770.37 birr with a minimum of 20594 to a maximum of 241697 birr. The corresponding result for irrigation non users was 31556.07 with a minimum of 4595 to a maximum of 103375 birr. The mean difference of

annual total crop production between the user and non-user of irrigation is statistically significant at 1 significance level.

Table 4.6 Summary of descriptive statistics for continuous variables by access to irrigation

Variables	Users (N=86)		Non users (N=92)		Total sample (N=178)		T-value for mean difference
	Mean	st.dev.	Mean	st.dev.	Mean	st.dev.	
Age	47.30	13.30	50.12	12.93	48.76	13.15	1.4326
Famsize	5.08	1.76	4.90	1.74	4.99	1.74	-0.6843
Output	91770.37	51848	31556.07	19337	60648.4	48925.8	-10.394***
Tru	4.86	2.05	4.77	1.82	4.82	1.93	-0.3696
Dismkt	3.02	1.53	3.89	2.04	3.47	1.86	3.2102***
Lansize	1.17	0.45	1.23	0.46	1.20	0.46	0.95

Source: Computed from own survey data, (2011)

Note: *** represent statistically significant at 1% significance level

4.2. Results and discussion of the econometric model

An econometric model, probit and Heckman two stage model was employed to identify the determinants of small-scale irrigation practice and its effect on farm income of rural farm households in Yilmana densa and Dera respectively. Before the estimation of the parameters of the model, the data have been tested for goodness of fit, multicollinearity and test of model adequacy statistical tests by using different commands of STATA software package.

Overall goodness of fit is tested using the Hosmer-Lemeshow method. The goodness of a model is reflected in a non-significant p-value. The test of model adequacy was also carried out based on the hatsq result. The insignificant p-value for _hatsq which is 0.767 suggests that the model is adequate. Therefore, we can say that there are no missed variables and the model is specified correctly and both goodness of fit and model adequacy stata result was presented in annex1 and annex 2 respectively.

One of the assumptions of the multiple regression models is that there is no exact linear relationship between any of the independent variables in the model. If such a linear relationship does exist, we say that the independent variables are perfectly collinear, and there is perfect collinearity.

Thus Multicollinearity problem arises when at least one of the independent variables is a linear combination of the others. If there is multicollinearity problem: standard errors are inflated, sign of the estimated regression coefficients may be opposite of hypothesized direction, smaller t ratios that might lead to wrong conclusions (Wooldridge, 2003). The variable included in the model was tested for the existence of multicollinearity, if there is among the included variables

Variance inflation factor (VIF) was used to check for multicollinearity among continuous variables and pearsons contingency coefficient was used to check multicollinearity among discrete variables. Based on the results of VIF, the data had no serious problem of multicollinearity. This is because, for all continuous explanatory variables, the values of VIF are by far less than 10. Similarly, the contingency coefficient results showed absence of strong association between discrete explanatory variables, since the respective coefficients were very low (less than 0.75). The result for continuous and discrete explanatory variables test for

multicollinearity was appeared in annex 3 and 4 respectively and that depicts the model is free from multicollinearity.

In Heckman,stwo stage selection model normality and homoskedasticity of the error term should hold (Green, 2003). Since these assumptions required to be tested, we tested hetroskedasticity for outcome equation and normality of the error terms. We used Breusch Pagan hetroskedasticity test to check existence of hetroskedasticity problem for errors. To check for normality of data, we have used the Shapiro Wilk test. For probit regression it is difficult to test hetroskedasticity problem. Thus, we assumed the presence of hetroskedasticity and apply robust during analysis to correct the problem for the participation equations and both results are presented in annex.

4.2.1 Results of Probit Model for the Determinants of small scale Irrigation practice

Out of the total eleven explanatory variables, output for the probit equation shows that five variables were found to be significantly creating variation on the probability of rural farm households, practice of irrigation or determine the probability of using irrigation. Variables found to be significant included; distance from the nearest market (dismkt), education level of the household head (educ), access to extension service (acc_ext), access to market information (accmkt), and sex of the household head (sex). With the above of background, the marginal effect of the significant explanatory variables on smallholder rural farm households, practice of irrigation was discussed below.

Table 47: Maximum likelihood estimates of the binary probit model and its marginal effect on the determinants of small scale irrigation practice

Variables	Std. err.	Z	p>|z|	Marginal effect
Age	0.00411	1.40	0.161	0.0057536
Accmkt	0.08288	6.34	0.000***	0.5250301
Educ	0.08692	5.15	0.000***	0.4472442
Sex	0.13598	2.43	0.015**	0.3299637
Famsize	0.03202	0.34	0.736	0.01007746
Acccr	.11553	0.89	0.106	.0245756
Accext	0.09439	3.69	0.000***	0.3482981
Soilfer	0.0893	1.28	0.201	0.1142426
Tru	0.03113	-1.23	0.219	-0.0382938
Dismkt	0.02603	-2.16	0.031**	-0.0562312
Lansize	0.13356	0.71	0.480	0.0944392
Cons	0.7275903	-3.47	0.001***	

Dependent variable practice of small scale irrigation

Log pseudo likelihood -76.217863

Wald chi2 (11) 72.44

Prob > chi2 0.0000

Pseudo R^2 0.3817

Number of observations 178

Source: computed from own survey data, (2017)

dy/dx(marginal effect) is for discrete change of dummy variables from 0 to 1

Note: ** and *** indicate significant at 5% and 1% level of significance respectively

Sex of household head (sex): The study found that Male headed household is more likely to adopt modern irrigation system than female headed household. Therefore due to sex difference of household head there is an influence in the practice of small-scale irrigation. The study result also reveals that sex of the household head is statistically significant at 5% level of significance and the marginal effect reveals that keeping all other variables constant at their mean value, male headed households have 32.99 percentage points more chance for practice of small-scale irrigation than female headed households or the discrete effect of change from 0 to 1 in sex of the household head increases the probability of small scale irrigation practice by 32.99 percentage points while keeping all other variables constant at their mean value or in another way if the dummy variable sex changes from zero to one, the probability for the variable irrigation practice taking the value one rises by 32.99 percentage points. This result is consistent with Hadush findings (2014).

Distance of the households residence from nearest market (dismkt): When farmers residence are far from the nearest market, the transaction cost for acquiring input and sale of output will be high and this will, in turn, reduce the relative advantage of small scale irrigation practice. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving to the market and to avoid such incidences the farmer sells his output for cheaper price reducing income as a result. Since farmers do not get reasonable price for their output, they become discouraged and stop from practice of small-scale irrigation. The results of the model showed that distance of farmers from the nearest market center is associated with the probability of the practice of small-scale irrigation negatively and significantly at 5% level of probability. The negative association implies that for a unitary increase in distance between the farmers residence and the nearest market centers, there will be less chance for use of small-scale irrigation. The marginal effect of this variable reveals that, keeping all other variables constant at their mean value, as the distance of farmers residence to the nearest market increases by one kilometer, the probability of small-scale irrigation practice reduces by 5.62 percentage points. Similar results were reported by Abdi (2015) and Haji (2003).

Level of Education of the household head (educ): Educated people can contribute to the generation of new technologies and more readily utilize those technologies. Moreover educated

peoples manage their fields properly and then activity results have pushes to get good production and productivity of the land. The study result indicates that the level of education acquired by head of the household is one of the key determinants of the probability of households use of small-scale irrigation and highly significant at 1% level of significance. This might be due to the fact that education of the household heads can raise their information acquisition and adjustment abilities thereby providing awareness regarding opportunities for productive employment and rational expectation decision making. Educational attainment by the household head could lead to awareness of possible advantages of modernizing agriculture by means of technological inputs; enable them to read instructions on fertilizer packs and diversification of household incomes which, in turn, would enhance households' food supply. The marginal effect of the variable shows that keeping all other variables constant at their mean value, literate household heads have 44.72 percentage points more chance of small-scale irrigation practice than those illiterate household heads. This result is consistent with Agerie(2016),

Access to extension services (acext): It is widely accepted that agricultural extension services play a pivotal role in the motivation of farmers towards the adoption of improved irrigation practices. The introduction of high valued crops, efficient use of water and proper use of inputs have all been deemed as significant factors for crop production and productivity (Madhusuda, B. et al. ,2002). The study result also reveals that access to extension service is statistically significant at 1% level of significance and the marginal effect reveals that those households who have access to extension service have 34.82 percentage points more chance of small-scale irrigation practice than those who have not access to extension service, while keeping all other variables constant at their mean value or the discrete effect of a change from 0 to 1 in access to extension service increases the probability of small-scale irrigation practice by 34.82 percentage points higher than their counterparts, holding other variables constant at their mean value. The same result was found by Mensah and Adebayo (2014).

Access to market information (accmkt): Information on markets is a determinant factor for irrigation technology adoption. Market information is crucial for producers to know the price of the product in relation to its quality, to know the demand of their product (number of consumers), this helps them to adjust their way of production. Access to market information

encourages farmers to produce more in quantity and in a quality of the product, because access to market information has positive influence in order to improve house hold's income in the study area. Moreover Market information helps farm households to market perishable farm products at the right time without loss of quality. Access to market information would also play a key role by providing accurate information on the demand and supply of farm inputs and outputs. The study result also reveals that access to information is statistically significant at 1% level of significance and the marginal effect revealed that those households who have access to information have 52.50 percentage points more chance of small-scale irrigation practice than those households who do not have access to market information, while keeping all other variables constant at their mean value or the discrete effect of a change from 0 to 1 in access to information of the household increases the probability of participation in small-scale irrigation by 52.50 percentage points while keeping all other variables constant at their mean value. This result is consistent with Asayehegn et al (2011) finding.

4.2.2 Result of Heckman two stage Model

This section attempts to address the effect of small-scale irrigation practice on households, total annual income in Yilmana Densa woreda. This can help to understand why some households are better than others to derive income from small-scale irrigation. Since many households do not practice small-scale irrigation their income is not observed for the non-users. Hence, applying ordinary least square (OLS) method using data from the participant samples only without correcting for selection bias can give us biased and inconsistent coefficients. For this reason we apply Heckman two stage selection models to estimate the outcome equations, because Heckman model helps as to consider observations that have missed data.

The results for the outcome equations of the Heckman-two-stage selection models are presented in Table 4.8. Here, results for the outcome equations are estimation results for determinants of income after correcting for selection bias. Based on the model output, the estimates of mills lambda (inverse Mills ratio), is statistically significant at 5% significant level providing evidence for the presence of selectivity bias and hence justifying the use of Heckman two-stage procedure in our model. The negative sign suggests that the error terms in the choice of irrigation and outcome equations are negatively correlated. This shows that those unobserved

factors that make the household to use small-scale irrigation are likely to be negatively associated with household income level too.

In our Heckman two step model output out of the total eleven explanatory variables for the output equation of the model, five variables are found to be significant determinants of household income. These are access to irrigation (irr), access to credit (accredit), total livestock holding (tru), distance from the nearest market (dismkt) and the inverse Mills ratio (lambda). The sign of coefficients of all variables have been as prior expectation. With this brief background, the effect of the significant explanatory variables on smallholder rural households, income level is discussed below.

Table 48: Heckman two-stage estimates for the output equation

Variables	Coefficients	Std.Err	p>|z|
Age	0.0013254	0.0033206	0.690
Irr	11.28237	0.3099818	0.000***
Sex	-0.1680264	0.1799672	0.350
Accmkt	-0.1075718	0.1162354	0.355
Famsize	-0.0004912	0.0279254	0.986
Acccr	0.4548295	0.1272401	0.000***
Accext	-0.0149332	0.1030214	0.885
Soilfer	9210.007	6793.579	0.175
Tru	0.1564223	0.0239027	0.000***
Dismkt	-0.1906657	0.0291983	0.000***
Lansize	0.0333834	0.100187	0.739
Lambda	-0.3068511	0.140422	0.029**

Dependent variable	total farm income
Number of observations	178
Censored observations	92
Uncensored observations	86
Wald chi2	37589.73
Pro>chi2	0.0000

Source: computed from own survey data,(2017)

Note: ** and *** represents significant at 5% and 1% level of significance respectively

Access to credit service (accr): Credit solves the liquidity constraints of households and it enables the farm households to purchase farm inputs such as seeds, fertilizers timely which all makes the production and productivity of a given farm plot increases. Access to credit is found to have a positive and significant influence on income of households, and it is statistically significant at 1% level of significance. According to the results of the study, keeping all other variables constant, on average households who have access to credit will produce an expected increase in log of Y_i of 0.4548295 than households who do not have access to credit. This result is consistent with Thegazeab and Dr.suraji(2016) findings.

Irrigation practice (irri): Irrigation practice, as one of the technology options available, enables the farmers to diversify their production, practice multiple cropping and supplement moisture deficiency in agriculture. As a result it helps the farmer to increase production and income. Therefore, use of irrigation influences the household total income significantly with a positive sign as expected. It is statistically significant at 1% level of significance. The result shows that, in the study area those who have access to irrigation have the chance of producing more marketed crops twice or more in a year as, a result those households who practice irrigation increased their income. The coefficient of this variable revealed that, keeping all other variables constant, on average irrigation user households will produce an expected increase in logY_i of 11.28237 than households who do not practice irrigation farming. Small-scale irrigation practice, therefore, enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption. This result is consistent with the findings of Dereje and Desale (2016), Agerie(2016).

Total livestock holding (tru): Livestock holding in tropical livestock unit contributes to total household income directly through the sale of livestock and their products and indirectly through use as a source of draught power for crop production activities. Livestock holding measured in Tropical Livestock Unit (TLU) is found to have a positive and significant influence on income of households, and it is statistically significant at 1% level of significance. Moreover Livestock, besides its direct role in raising agricultural productivity, helps households stabilize consumption by absorbing income shocks that might arise from crop failures triggered by natural disasters. Households with larger number of livestock particularly oxen, therefore, are likely to raise farm income for they can use other farm inputs more efficiently by bringing

additional land into cultivation through either cash rent or share cropping basis. The study result revealed that, a unit increase of livestock holding in TRU will produce an expected increase in $\log Y_i$ of 0.1564223, while keeping all other variables constant at their mean value. The same result was found by Asayehegn et al (2012).

Distance of the households residence from the nearest market (dismkt): The results of the output model showed that distance of farmers' farm from the nearest market affects households, annual farm income negatively and significantly at 1% level of significance. The negative association implies that for a unitary increase in distance between the farmers' farm and the nearest market centers, there will be less change for generating income. When farms are far from the market, the transaction cost for acquiring input and sale of output will be high and this will, in turn, reduce the relative advantage of participating in different economic activities including small-scale irrigation. As the farmers, farm was not near to the market that might increase costs of marketing the products. The farther the market center is, the lower the income from sell of farm products. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving market and to avoid such incidences the farmer sells his output for cheaper price that reduce the income The model result indicates that a unit increase of the distance of farmers, residence to the nearest market will decreases $\log Y_i$ by 0.1906657 keeping all other variables constant at their mean value. A similar result was reported by Hadush (2014) and this implies that distance of the household residence from the nearest market has an influence on households, farm income.

CHAPTER FIVE: CONCLUSION AN D RECOMMENDATIONS

5.1. Conclusions

The overall objective of this study was to evaluate the determinants of households, small scale irrigation practice and its effect on farm income in Yilmana densa woreda. Data for the study were collected from randomly selected rural households using structured interview schedule in four kebeles of this woreda namely Adet zuria, Goshe ye, Diwaro and Gube.

Both Quantitative and qualitative data types related to determinants of small scale irrigation practice and its effect on farm income were collected from primary sources through sample respondents and secondary sources also used to enrich data from primary sources. Two types of respondents; irrigation users and non-users were considered for the survey. The sample size is 178 (86 irrigation users and 92 non users)

Probit and Heckman two stage model was employed to examine the determinants of small scale irrigation practice and effect of small scale irrigation on farm income respectively. Heckman two stage model was preferred to minimize problems associated with selection bias. Descriptive statistical analysis was carried out and compared the mean of the two groups (irrigation users and irrigation non-users) with respect to important demographic, socioeconomic and institutional variables. Chi-square test was applied to statistically compare irrigation users and non users for the discrete variables where t-test was applied to statistically compare the two groups for continuous variables.

Irrigation user households have significantly larger mean annual income as compared to irrigation non-user households. This indicates access to irrigation increases the opportunity for crop intensity and diversification, which increase agricultural production and income. Having access to irrigation had significantly improved the living standards of farming households by increasing their farm income since in addition to their normal rained production, irrigating households cultivate cash crops using small scale irrigation. The main irrigated crops were garlic, potato, carrot, tomato, pepper, and cabbage. These crops were mostly produced due to good production potential, economic returns and ease of cultivation.

From the estimation result of the marginal effect of the probit model for the determinants of smallholder rural farm households, small-scale irrigation practice five variables were found to

be significant on the probability of rural farm households, small-scale irrigation practice. The variables that become statistically significant include: access to market information, sex of the household head, access to extension service, education level of the household head and distance from households, residence to the nearest market.

Male-headed households have higher probability of participation in small-scale irrigation compared to female-headed households. This indicates that women have not benefited much from small scale irrigation. Literate household heads have high probability of participation in small-scale irrigation than the illiterate once. Distance of households, residence to the nearest market negatively and significantly associated with households, small-scale irrigation practice. Access to market information is positively and significantly determining practice of small scale irrigation. This indicates that household heads who have access to market information uses small scale irrigation better than those that have no the access. Furthermore, access to extension service affect small scale irrigation practice positively and significantly.

The Heckman two stage estimation results showed that access to irrigation, access to credit service, total livestock holding and distance of the household residence from the nearest market are significantly associated with household total annual farm income. Access to irrigation has positive and significant effect on households, annual income which indicates that a household who utilizes small scale irrigation earns higher annual income than those who did not utilize.

Access to credit service positively and significantly affects households, total annual income. This indicates households who receive credit service have higher annual income than those who do not have access to credit. Furthermore, total livestock holding has a positive and significant effect on annual income in the study area. But distance of households, residence from the nearest market has a negative and significant effect on households, annual farm income. This indicates a household far from the market generates less annual farm income than those who are near to the nearest market center. This might be due to higher transport cost to sell their products and since distance of the household residence from the nearest market affects irrigation practice negatively which in turn reduced their annual farm income.

5.2. Recommendations

Based on the findings what we have got in the analysis part, in both descriptive and econometric analysis, the following policy recommendations can be drawn for further consideration and improvement of small scale irrigation development and farm income in Yilmanadensa woreda in particular and in West gojjam zone in general

Since the study revealed that participation in small scale irrigation increases household farm income, the district administrators and the Zonal government should incentivize farm households to use small scale irrigation and try to expand its accessibility for those households who are not at river side through water conservation and dig underground water for small-scale irrigation since it is valuable for future development.

The study revealed that the number of livestock holding in terms of TLU influence a household farm income positively and significantly. Therefore, to increase income of farm households should be given due attention to develop the livestock sector at least in the following areas: feed resource improvement and management, genetic resource improvement, prevention of animal diseases and parasites and development of marketing facilities for animals and animal products.

Access to extension service is a corner stone of agricultural practices in general and small scale irrigation development in particular. Access to extension services was positively and significantly related to households, participation in small-scale irrigation. Therefore we recommend local governments to train quality development extension agents especially small scale irrigation experts in adequate number to increase the frequency of contact and flow of information between the extension agents and farm households to increase their participation in small scale irrigation.

The probit model for adoption decision indicates that female-headed households have less probability in adoption of small scale irrigation. Therefore, the local government has to find out ways to increase the probability of participation and improve gender equality. For instance, insuring property ownership (e.g. motor pump) to female-headed households and provide subsidized credits as a some mechanism of increasing female-headed household,s participation in small-scale irrigation.

Education has a significant effect for the adoption of small scale irrigation by a household. The descriptive and econometric model analyses indicate that literacy has a large positive effect in practice of small scale irrigation. These effects likely occur because illiterate households have difficulty in accessing extension services and adoption of new technologies. Therefore Households in collaboration with the local leaders and other stake holders should invest in the expansion of schools as education is found to be statistically significant in increasing participation in small-scale irrigation.

The study reveals that distance of farm households residence from the nearest market affect both adoption of small scale irrigation and total farm income negatively. Returns to irrigation are affected by the marketing channel, in part because the main irrigated crops are harvested at similar times by farmers and are perishable. Therefore, the local governments and the zonal administrative body should provide better infrastructure like access to road and transportation service to decrease the time taken to reach the nearest market which in turn reduce the incidence of perishable commodities to perish before reaching the market. In addition to this the local administrative body should establish irrigation co-operative and integrate to market that is crucial for the farmers to get reasonable price for their produce.

Access to market information is positively and significantly determining the use of small scale irrigation. Thus, the concerned body should provide information related to use of small-scale irrigation. The strategy should use appropriate ways of disseminating information related to use of technology to households in line with what to produce, how to produce, when to produce, how much to produce and in what price.

Access to credit service has positive and significant effect on total farm income. Since it can solve the liquidity constraints of households and it enables the household to increase their production and productivity, local governments, formal and informal credit institutions should provide credit service for each household.

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7. APPENDIXES

Appendix 1: Test of overall goodness of fit

Probit model for irr, goodness-of-fit test

number of observations =	178
number of covariate patterns =	178
Pearson chi2(166) =	147.17
Prob > chi2 =	0.8505

Appendix 2: Test of model adequacy

Probit regression

		Number of obs	= 178
		LR chi2(2)	= 94.21
		Prob > chi2	= 0.0000
Log likelihood = -76.175204		Pseudo R2	= 0.3821

irr	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	1.001368	.1384822	7.23	0.000	.7299477	1.272788
_hatsq	-.0326031	.1098192	-0.30	0.767	-.2478448	.1826386
_cons	.02331	.1417142	0.16	0.869	-.2544447	.3010648

Appendix 3: Variance inflation factor for continuous variables

Variable	VIF	1/VIF
tru	1.77	0.565331
output	1.59	0.627098
dismkt	1.41	0.709653
famsiz	1.38	0.722993
lansiz	1.30	0.768361
age	1.22	0.821076
Mean VIF	1.45	

Appendix 4:pearsons Contingency coefficient for dummy (discrete) variable

	irr	accmkt	educ	sex	acccr	accext	soilfer
irr	1.0000						
accmkt	0.4663	1.0000					
educ	0.4199	0.1898	1.0000				
sex	0.2407	0.1422	0.2241	1.0000			
acccr	-0.0954	-0.0347	0.0138	-0.0912	1.0000		
accext	0.3243	0.2769	0.1753	-0.0912	0.0119	1.0000	
soilfer	0.1979	0.2287	0.1264	0.0419	0.0346	0.0916	1.0000

Appendix 5: Shapiro-Wilk tests for Normality

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
age	178	0.98256	2.352	1.956	0.02522
famsiz	178	0.98729	1.714	1.232	0.10900
tru	178	0.99237	1.028	0.064	0.47452
dismkt	178	0.92835	9.661	5.188	0.00000
lansiz	178	0.97461	3.424	2.815	0.00244

Appendix 6: Test of hetroskedasticity of the error term

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of output

chi2(1) = 57.56

Prob > chi2 = 0.0000

Appendix 7: Marginal effects of the probit model for the determinants of households, participation in small-scale irrigation

```
Marginal effects after probit

  y = Pr (irr) (predict)

   = .50454082
```

variable	dy/dx	Std. Err.	z	P>|z|			
age	.0057536	.00411	-.002301	1.40	.013808	0.161	48.7584
accmkt*	.5250301	.08288	6.34	0.000	.36		
educ*	.4472442	5.15	.08692	0.000	.276874	.617614	
sex*	.3299637	.13598	2.43	0.015	.0		
famsiz	.0107746	.03202	-.051974	0.34	.073523	0.736	4.98876
acccr*	.0245756	.11553	-.451012	0.89	[illegible]1861	0.106	.151685
accext*	.3482981	.09439	3.69	0.000	.1		
soilfer	.1142426	.0893	-.060776	1.28	.289261	0.201	1.4382
tru	-.0382938	[illegible]	0.[illegible]	-.099314	.022726	4.82014	
dismkt	-.0562312 03	[illegible]	0[illegible]	[illegible]05216	3.47306		
lansiz	.0944392	.13356	-.167332	0.71	.35621	0.480	1.20225

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Appendix 8: Stata output for Heckman two stage model

Heckman selection model -- two-step estimates (regression model with sample selection)

Number of obs	= 178
Censored obs	= 92
Uncensored obs	= 86
Wald chi2(10)	= 37589.73
Prob > chi2	= 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnincome						
age	.0013254	.0033206	0.40	0.690	-.0051828	.0078336
irr	11.28237	.3099818	36.40	0.000	10.67482	11.88992
accmkt	-.1075718	.1162354	-0.93	0.355	-.335389	.1202454
sex	-.1680264	.1799672	-0.93	0.350	-.5207557	.1847029
famsiz	-.0004912	.0279254	-0.02	0.986	-.055224	.0542417
acccr	.4548295	.1272401	3.57	0.000	.2054434	.7042155
accext	-.0149332	.1030214	-0.14	0.885	-.2168514	.1869851
tru	.1564223	.0239027	6.54	0.000	.109574	.2032707
dismkt	-.1906657	.0291983	-6.53	0.000	-.2478934	-.133438
lansiz	.0333834	.100187	0.33	0.739	-.1629796	.2297464
irr						
age	.0148792	.0104316	1.43	0.154	-.0055664	.0353248
accmkt	1.573896	.3782921	4.16	0.000	.8324568	2.315334
educ	1.177199	.276933	4.25	0.000	.6344199	1.719977
sex	.8976596	.411452	2.18	0.029	.0912285	1.704091
famsiz	.0302015	.08004	0.38	0.706	-.126674	.1870771
acccr	-.5788658	.3897523	-1.49	0.137	-1.342766	.1850347
accext	.9305419	.2752499	3.38	0.001	.3910619	1.470022
tru	-.0912368	.0771451	-1.18	0.237	-.2424385	.0599649
dismkt	-.1431773	.0684823	-2.09	0.037	-.2774001	-.0089544
lansiz	.254142	.3246485	0.78	0.434	-.3821574	.8904414
soilfr	.4212972	.2431313	1.73	0.083	-.0552314	.8978258
_cons	-2.376588	.7557961	-3.14	0.002	-3.857921	-.8952548
mills						
lambda	-.3068511	.140422	-2.19	0.029	-.5820732	-.0316291
rho	-0.79498					
sigma	.38598786					

Appendix 9: Structured interview schedule

Bahir Dar University

Department of Economics

Household Survey Questionnaire

Instruction to the Interviewer: Greet the person you are interviewing and Read the following to the respondent:

How are you, I am----------. I am assisting an ongoing research by Birhanu Alamirew for the partial fulfillment of his MSc. degree in development economics at Bahirdar University. This questionnaire is prepared to undertake a study on "Determinants of Smallholder Farm Households' Small Scale Irrigation practice and Its Effect on farm income". The interview will take a few minutes and the answer will be completely confidential and strictly used for academic purpose only. Your name will never be associated with your answers. There are no correct or wrong answers. The result of this study will help different stakeholders and policy makers to make appropriate measures on irrigation development in the future. Therefore, you are kindly requested to provide genuine responses related with socio economic and other important information. Thank you for your time and cooperation!

1. Identification Information

1.1. Name of Kebele_____

1.2. Category of the household (put X mark) 1) Irrigation user_____ 2) non-user_____

1.3. Irrigation Type (put X mark) 1) Modern_____2) Traditional_____

2. Household Socio-economic and infrastructural characteristics

2.1. Household identification number: _____

2. 2. Age of the household head _____

2.3 Sex of the household head (circle the answer) 1= Male 0 = Female

2.4 Education level of the household head(circle the answer) 1= literate 0=Illiterate

2.5 Total family numbers of the household_____

2.6. What time takes from the nearest market place to your home? _____

2.7. Are you irrigation user? (Circle answer) 1 = yes 0 = no

2.8. If the answer is no what is the reason? (multiple answers are possible)

1) Fear of diseases

2) No information about irrigation

3) Shortage of water

4) Topography of land

5) No access of land

2.9. Do you think that irrigation has a positive effect on output (circle one) 1 = yes 0 = No

2.10. If your answer is yes, what are the positive effects of irrigation? (multiple answers are possible)

1) Increased agricultural production

2) Diversification of crops

3) Increased household income

4) Other specify

2.11. Have you cultivated the total of your irrigable land? (circle the answer) Yes =1 , No = 0

2.12. If your answer for question 2.12 is †No, what is the reason? (multiple answers are possible)

1 =Shortage of family labor

2 = lack of seed

3 = lack of oxen

4 =enough production rain fed

5 =lack of credit

6 = others specify

3. Resource endowments and access to credit and extension issues

3.1. Do you possess your own land? (Put x mark)-Yes-----No-----

3.2. If yes, its total area in hectare---- Area under irrigation----- Area under rain fed-----

3.3. How did you get your land? (Put x mark)

1) Inherited from family-------- 2) Gift from relatives/on kinship basis-----3) Purchase-------

4) Rent--------- 5) Government redistribution---------- 6) Others specify:----------

3.4. Do you rear livestock?(circle one) 1= Yes, 0 = No

3.5. What livestock types and number do you own?

No	Type of animal	Number of animals
1	Oxen	
2	Bulls	
3	Cows	
4	Calf	
5	Sheep	
6	Goats	
7	Mules	
8	Chicken (poultry)	
9	Horses	
10	Donkeys	

3.5. If you did not have enough oxen what do you use for your farm operation? (Put X mark)

1. Exchange with labor„„„„„ 3. Exchange (by grass or hay)„„„„..

2. Hire oxen (rent)„„„„„„„ 4. Others (specify)„„„„„„„„„

3.6. Did you need extension package program for the production of your agricultural products?

1 = Yes 0 = No

3.7. If yes, did you have access? (Circle one) 1= Yes 0= No

3.8. If yes, did you gain any knowledge from the extension agents that could help you to do things differently on the specific commodities?

0 = No 1 = Yes If no, specify your reason_____

3.9. Did you need credit for the production of your agricultural products? 1 = yes 0 = No

3.10. If yes, did you have access to credit for the production of the Commodities? 1 =Yes 0 = No

3.11. If yes what are the sources?(circle one)

1. Neighbors and relatives 2. Local lenders

3. Banks 4. Micro finance 5. Others specify----------

3.13. Do you get market information about prices and demand conditions of agricultural inputs and out puts? 0 = No 1 = Yes, if yes indicate the source of information_____

3.14. How do you see the fertility status of your land (circle one)?

1. Fertile 2.moderatly fertile 3. Infertile

3.15. Crops produced by the household

Crop type	Amount produced this year
Cereals	
Teff	
Maize	
Wheat	
Barley	
Others	
Fruits and vegetables	
Bean	
Pea	
Potato	
Onion	
Garlic	
Cabbage	
Pepper	
Tomato	
Others	