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Determinants of Smallholder Rural Farm Households' Participation in Small Scale Irrigation and Its Effect on Income in North Gondar Zone: A Cross-Sectional Approach (Evidence from Dembia Woreda)

By:

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Master of Science Degree in Economics (Development Policy Analysis Specialization)

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Statement of Declaration

I**, Agerie Nega Wassihun**, hereby declare that this thesis work entitled "**Determinants of Smallholder Rural Farm Households' Participation in Small Scale Irrigation and Its Effect on Income in North Gondar Zone: A Cross-Sectional Approach (Evidence from Dembia Woreda)"** Submitted by me in partial fulfillment of the requirements for the award of the degree of Master of Science in Economics to the College of Business and Economics, Mekelle University, through the Department of Economics, is original work carried out by myself. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief. Where other sources of information have been used, they have been duly acknowledged.

Name of the student: Agerie Nega Wassihun

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Date ___________________________

Statement of Certification

This is to certify that this thesis entitled "**Determinants of Smallholder Rural Farm Households' Participation in Small Scale Irrigation and Its Effect on Income in North Gondar Zone: A Cross-Sectional Approach (Evidence from Dembia Woreda)"** submitted in partial fulfillment of the requirements for the award of the degree of MSc. in Economics (Development Policy Analysis), to the College of Business and Economics, Mekelle University, through the Department of Economics, done by **Mr. Agerie Nega Wassihun,** Id.No. CBE/PR093/04 is a genuine work carried out by him under my guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief.

Principal Advisor: Woldegebriel Abrham (PhD)

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Co-advisor: Kibrewossen Abay (M.Sc)

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Mekelle, Ethiopia

Dedication

I dedicate this thesis manuscript to my parents, brothers and sisters for nursing me with affection and for their wholehearted partnership in the victory of my life.

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Abstract

Agricultural intensification is presumed to be a necessary pre-condition for the development of the agricultural sector in Ethiopia in general and in North Gondar Zone in particular. To this end, various governmental and non-governmental organizations (NGOs) initiated small-scale irrigation schemes throughout the country including the Amhara region. Despite these efforts, however, smallholder farmers in the study area are found to be reluctant to participate in small-scale irrigation schemes. Therefore, this study analyzed and investigated the factors that affect participation of smallholder farmers in small-scale irrigation and also it explored the effect of participation in small-scale irrigation on the income of rural farm households in Dembia Woreda of North Gondar Zone. Three stage sampling procedure was adopted for the selection of sample respondents. Results are based on data collected from a survey of 240 randomly selected rural farm households. Descriptive statistics and Heckman's two-stage estimation were used to estimate determinants of small-scale irrigation participation and household income. The analysis revealed that distance from households farm to the nearest market center, education level of the household head, distance from households residence to the water source, access to extension service, total livestock holding, access to information, availability of family labor force, access to credit and gender of the household head are important determinants for participating in small- scale irrigation schemes. The analysis further revealed that irrigation participation, access to credit, gender of the household head, size of cultivated land, access to extension service and total livestock holding are positively and significantly associated with household total annual income. Finally, based on both descriptive and econometric results, improving rural farm households' access to extension service and livestock sector, are likely to enhance participation in small-scale irrigation schemes thereby improve small holder rural farm households total annual income.

Keywords: *Small-scale Irrigation; Income; Rural Farm Households; Heckman two stage model; User; Non-user; Dembia; North Gondar; Ethiopia*

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List of Acronyms

ACSI	Amhara Credit and Saving Institution
ADLI	Agricultural Development Led Industrialization
ANRS	Amhara National Regional State
BOARD	Bureau of Agriculture and Rural Development
BOWRD	Bureau of Water Resource Development
CC	Contingency Coefficient
CSA	Central Statistical Authority (Ethiopia)
DA	Development Agents
DOARD	District Office of Agriculture and Rural Development
DOFED	District Office of Finance and Economic Development
DOID	District Office of Irrigation Development
EDRI	Ethiopian Development Research Institute
ESSP	Ethiopia Strategy Support Program
ETB	Ethiopian Birr (Currency)
FAO	Food and Agricultural organization
GDP	Gross Domestic product
GOV	Government of Ethiopia
IDD	Irrigation Development Department
IFPRI	International Food Policy Research Institute
IWMI	International Water Management Institute
KM	Kilometers
MOARD	Ministry of Agriculture and Rural Development
MOFED	Ministry of Finance and Economic Development
MOWE	Ministry of Water and Energy
NGO	Non-Governmental Organizations
OLS	Ordinary Least Squares
SWCD	Soil and Water Conservation Department
TLU	Tropical Livestock Units
UNDP	United Nations Development Program
VIF	Variance Inflation Factors

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Agriculture contributes substantially to the economic growth of many low-income countries. It is often the leading sector of the economy as source of income, employment and foreign exchange. More than half of the less developed countries population gets their food from own-production. Agricultural output also is used as an input for industries so it can stimulate the growth of industrialization. Improving agricultural productivity thus contributes to income growth (UNDP, 2007).

Ethiopia, like other Sub-Saharan African (SSA) countries, is predominantly an agrarian country with the vast majority of its population directly or indirectly involved in agriculture where around 95% of the country's agricultural output is produced by small holder farmers (MoARD, 2010). Hence it is the backbone of Ethiopian economy; it contributes about 50 % of the GDP, 85% of the employment, 90% of the export earnings and 70% of the supply of industrial raw materials (World Bank, 2010).

Although the country is endowed with three main resources namely land, water and labor for agricultural production, the sector in the country is mostly small- scale, rainfall dependent, traditional and subsistence farming with limited access to technology and institutional support services. Hence, the ability of the nation to address food and nutritional insecurity, poverty, and to stimulate and sustain national economic growth and development is highly dependent on the performance of agriculture. Yet achieving higher and sustained agricultural productivity growth remains one of the greatest challenges facing the nation (Belay and Degnet, 2004; Spielman et al., 2010). Rain fall is erratic and unevenly distributed between seasons and agro ecological regions lead to poor yields, low productivity, food insecurity and poverty within the farming population, thus it emphasizing the need for irrigation in the counrtrry.

Small-scale irrigation is irrigation, usually on small plots where small farmers have the majority controlling influence, using a level of technologies which they can operate and maintain effectively. Small-scale irrigation is, therefore, farmer-managed i.e. farmers must be involved in the design process and, in particular, with decisions about boundaries, the layout of the canals, and the position of outlets and bridges. The preference for small-scale schemes is based on the perceived easy adaptability of the systems to local environmental and socioeconomic conditions (Vaishnav, 1994).

Currently, the 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 postharvest technologies. To this end, the objective of the growth and transformation encompasses i) achieving a sustainable increase in agricultural *productivity* and production; ii) accelerating agricultural *commercialization* and *agro-industrial development*; iii) reducing degradation and improving productivity of natural resources; and iv) achieving universal food security and protecting vulnerable households from natural disasters (MoARD,2010). This potentially and intensively utilizes the three major resources (land, labor, and water) for its productivity focused and intensive agriculture. The land resource potential as an opportunity is due to that all the agro ecologies (lowland, midland and highland) are found in which more than 80% of the country is potentially suitable for agriculture. While the reasons for labor is that, With a population of about 80 million, living in a total land area of 1.1 million sq km, the country is the second most populous country in Africa with unemployment, under employment and disguised un employment (CSA July 2010). Similarly, the country is endowed with numerous water sources including the twelve longest rivers such as the Blue Nile. Hence, irrigation is a means by which agricultural production could be increased to meet the growing food demand. Increasing food demand could be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land and increasing cropping intensity. Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristics of large parts of the country’s land and increasing population. Increasing yields in both rain-fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are therefore the most viable options for achieving food security (IWMI, 2005).

Irrigation contributes to livelihood improvement through increased income, food security, employment opportunity, social needs fulfillment and poverty reduction. Increase in agricultural production through diversification and intensification of crops grown, increased household income because of on/off/non-farm employment, source of animal feed, improving human health due to balanced diet and easy access and utilization for medication, soil and ecology degradation prevention and asset ownership are contributions of irrigation (Asayehegn, 2012).

According to Haile (2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty, through: (i) *increasing production* and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) *protecting against risks of crop* loss due to erratic, unreliable or insufficient rainwater supplies, (iii) *promoting greater use of yield enhancing farm inputs* and (iv) creation of additional employment, which together enables people to move out of the poverty cycle. In the same way, Zhou et al. (2009) mentioned that irrigation contributes to agricultural production in two ways: increasing crop yields, and enabling farmers to increase cropping intensity and switch to high-value crops. Therefore, irrigation can be an indispensable technological intervention to increase household income.

Hussain and Hanjira (2004) confirmed a strong direct and indirect linkage between irrigation and poverty. Direct linkages operate through localized and household level effects, whereas indirect linkages operate through aggregate or sub-national and national level impacts. Irrigation benefits the poor through higher production, higher yields, lower risk of crop failure, and higher and year-round farm and non-farm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value staple production to high-value market-oriented production. Increased production makes food available and affordable for the poor (Asayehegn et al., 2011).

Since irrigation investments leads to production and supply shifts, indirect linkages operate through regional and national level and have a strong positive effect on the national economy. The study conducted from Gambia revealed that irrigation provided smallholder farmers the chance for increasing income that was reflected on increased expenditure, investment in productive and household assets, saving and trade (Webb, 1991). In India poverty head count ranges from18 to 53% in irrigated and 21 to 66% in rain fed areas and poverty incidence is 20 to 30% lower in most irrigated areas compared to rain fed areas. Incidence of chronic poverty is 5% lower for irrigated areas in Sri Lanka (Pakistan) than adjoining rain fed areas (Hussain and Hanjra, 2004).

Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation and growth (MOFED, 2006), as well as climate adaptation (GoE, 2007). Only around 5% of Ethiopia's irrigable land is irrigated (World Bank, 2006), and less than 5% of total renewable water resources are withdrawn annually (FAO, 2005), so there is considerable scope for expansion.

The current government of Ethiopia has undertaken various activities to expand irrigation in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable development. Thus, there is a need or a plan to accelerate irrigation particularly small-scale irrigation.

The development of small-scale irrigation is one of the major intervention areas to boost agricultural production in the rural parts of the country. This helps poor farmers to overcome rainfall and water constraint by providing a sustainable supply of water for cultivation and livestock, strengthen the base for sustainable agriculture, provide increased food security to poor communities through irrigated agriculture and contribute to the improvement of human nutrition(FAO, 2003).

The Amhara region, with a population of about 18 million, is the second most populous administrative region in Ethiopia (CSA, 2007). Like in other eight regions of Ethiopia, 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 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, degraded natural resource base, high population density and low productivity caused by poor agricultural management practices. In the region, an estimated 18-20% of the population is chronically food insecure (BoARD, 2003). With this background, this study is designed to identify and analyze factors that determine farmers' participation in small-scale irrigation and its effect on income in Dembia woreda of North Gondar Zone, and through that make recommendations to improve the effectiveness of interventions.

1.2 Statement of the Problem and Justification

Agricultural production in Ethiopia is primarily rainfed, so it depends on erratic and often insufficient rainfall. As a result, there are frequent failures of agricultural production. 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; CSA 2007). Population growth causes agricultural activities expands into marginal land, which leads to forest, land and water degradation. This environmental degradation can reduce agricultural productivity, which in turn worsens food insecurity and poverty. In order to respond to growing food demand, some proportion of the pressure could be met by increasing productivity rather than extensive agriculture. The three methods to increase food production are: increasing agricultural yield per a given plot, increasing the area of arable land, and increasing cropping intensity (number of crops per year). Irrigation has the potential to increase both yields and cropping intensity in Ethiopia (Awulachew et al., 2010).According to previous studies (Nhundu et al., 2010; Gebremedhin and Peden 2002; Hussain 2006) irrigation increases agricultural productivity and farm income per hectare. It insulates the national agricultural economic sector against weather-related shocks and provides a more stable basis for economic growth and poverty reduction. It supports the process of transforming traditional subsistence agriculture into market-oriented production of high value crops (Asfaw, 2007).

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

Amhara region is endowed with a potential irrigable land area of 0.6 million ha (3.9%) out of total land mass of 15.5 million hectare within the four major river basins (Awulachew et al., 2005; BoWRD, 2005). In addition, it enjoys a considerable potential for surface water harvesting by small-scale dams and river diversions and also underground water resources. However, the total area under irrigation to date amounts only to about 76 thousand ha, this is less than 2% of the total cultivated land in the region (BoWRD, 2005). North Gondar zone is an irrigation potential area. Using this huge potential, smallholder farmers' in the study area benefited from participation in small-scale irrigation through increasing cropping intensity as a result the living standard of the community improves. But, it is not surprising to find some households reluctant to participate in small-scale irrigation schemes depend on rainfed agriculture alone and the output produced is not sufficient to feed their household. However, the causes for the low participation is not clearly identified and known in the area.

Furthermore, researches on factors impeding participation of smallholder rural farm households in small-scale irrigation and its effect on income are not extensive in the study area. Some of them are: Haile (2008), Impact of irrigation development on poverty reduction in Northern Ethiopia; Abonesh et al.(2006), Impact of small scale irrigation on household food security: the case of Filtino and Godino irrigation schemes in Ethiopia; Asayehegn et al.(2011),Effect of small-scale irrigation on the income of farm households in Laelay Maichew,Tigray; Getaneh (2011), Impact of selected small-scale irrigation schemes on household income and the likelihood of poverty in the lake Tana basin of Ethiopia; Rahel (2008),Institutional analysis of water management on communal irrigation systems in Ethiopia: the case of Atsbiwemberta, Tigray region and Ada'a woreda,Oromiya region. Most of these and other studies in Ethiopia focus on technical aspects of irrigation schemes and farm specific impact of small-scale irrigation participation and very little is known for the socio-economic factors that have implications on irrigation participation (Van Den Burg and Ruben, 2006). More importantly, in North Gondar Zone, where this study was conducted, studies are scanty and there are no published works on the factors that determine small holder farmers' participation in small-scale irrigation and its effect on income. To fill this knowledge gap it needs to be backed up with research. Hence, this study addresses the potential incentives that promote small holder farm households' participation and the constraints or barriers that hinder participation in small-scale irrigation schemes. In general, there exists little empirical evidence related to the determinants of participation in small-scale irrigation and its effect on income of rural farm households.

Therefore, this study is aimed at primarily identifying, analyzing, and documenting the socio-economic and institutional factors affecting household level irrigation utilization and income that contributes its part to the existing body of knowledge. Secondly, it provides a base for policy makers and gives directions for further research, extension and development schemes that will benefit the scheme beneficiaries.

1.3 Research Objectives

1.3.1 General Objective

The ultimate objective of the study was to identify and analyze major socio-economic and institutional factors impeding participation of smallholder rural farm households in small-scale irrigation and its effect on income in North Gondar Administrative Zone, in general and in Dembia Woreda, in particular, and through that make recommendations to improve the effectiveness of interventions.

1.3.2 Specific Objectives

- To identify and analyze the determinants of small scale irrigation utilization by smallholder farmers
- To explore the effect of small scale irrigation participation on the income of smallholder rural farm households
- To determine the relative importance of the factors affecting small scale irrigation participation and income

1.4 Research Questions

In this study the following research questions were addressed:

1) Which variables determine participation in small scale irrigation of the smallholder farm households in the study area?
2) Do the factors that affect small scale irrigation participation can also affect the level of income of smallholders?
3) Which variables largely affect the participation in small scale irrigation and income in the study area?

1.5 Significance of the Study

The study is significant for it increases individuals' understanding regarding the factors that influence smallholder farm household's participation in small-scale irrigation and its effect on income. Research on issues concerning determinants of participation of smallholder rural farm households in small-scale irrigation for the rural poor is crucial for formulating programs for the alleviation of poverty. The study gives a clue for policy makers and planners towards major bottlenecks of poor farm households' participation in small-scale irrigation and its effect on income in the study area. The findings of the study can be used by local administrators and NGOs in order to devise interventions that can help to improve the livelihoods of the rural poor and it also 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 and income. The study result might also be used as a reference and initiate other researchers who are interested in conducting different research works from different perspectives on the field which improve the performance of the dominant sector.

1.6 Scope and Limitation of the Study

The study is undertaken in North Gondar zone of Amhara region, Dembia woreda. In order to evaluate the gathered data effectively and maintain the scope within a stipulated time and financial limit, the study is conducted to one woreda with five kebeles only and emphasized on a limited number of households (240 HHs) and determinants of small holder farm households' participation in small-scale irrigation and its effect on income only without taking into account other dimensions of small-scale irrigation. Household survey by itself is complex and to get reliable data especially on household land holding, volume of production, income, number of livestock as well as other variables which have close economic and social implications are not always free from error. Households can only recall the most recent information and it is not possible to get time series data since farmers do not keep records and due to mind lapse.

1.7 Organization of the Thesis

This thesis has been 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 presents the literature review and Information on the previous works and empirical findings have been properly sifted out and entertained. Chapter three presents the data source, methodology and model specification. In this chapter the description of the study area, the sources of data, the methods used to obtain the data and the theoretical and econometric models used to analyze the data set are presented. Chapter four gives the investigation and interpretation of descriptive and econometric analysis. Finally, conclusions drawn from the analysis of the data and policy implications as well as recommendation are given in chapter five.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Concepts and Definitions

To date, three broad components of water resources development can be mentioned. These are water for domestic use (drinking, food preparation, cleaning, etc), irrigation development and hydropower production. However, the concern of this paper is on irrigation development with a special emphasis on small-scale irrigation schemes.

Irrigation is defined as the artificial application of water to arid land for growing crops. It is a profession as well as a science. A crop requires certain amount of water at certain fixed intervals throughout its period of growth. Irrigation is required at dry and last rainy period's .Because at dry period irrigation give important role in order to produce food crops and cash crops, also at last rainy period as Ethiopian situation especially some parts of Amhara region rainy season as observed rainfall starts late and ends early, so in order to supplement the crop irrigation provides a greatest role in order to produce more yield.

In tropical countries like Ethiopia, the first two of three essential requirements of plant growth, that is, moisture needs to be supplemented frequently by artificial application of water. Thus, irrigation is supplementary to rainfall when it is either deficient or comes irregularly or at unreasonable times.

Water is the greatest resource of humanity. It not only helps in survival but also helps in making life comfortable and luxurious. Besides various other uses of water, the largest use of water in the world is made for irrigating lands.

Irrigation, infact, is nothing but "a continuous and reliable water supply to the different crops in accordance with their different needs". When sufficient and timely water does not become available to the crops, the crops fade away, resulting in lesser crop yield, consequently creating famine and disasters: irrigation can, thus, save us from such disasters.

Irrigation is one means by which agricultural production can be increased to meet the growing demands in Ethiopia (Awulachew et al. 2005). A study also indicated that one of the best alternatives to consider for reliable and sustainable food security development is expanding irrigation development on various scales, through river diversion, constructing micro dams, water harvesting structures, etc. (Robel, 2005).

Small-scale irrigation can be defined as 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 et al. (1997) defines SSI are 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: farmers must be involved in the design process and, in particular, with decisions about boundaries, the layout of the canals, and the position of outlets and bridges. Although some small-scale irrigation systems serve an individual farm household, most serve a group of farmers.

Smallholder: The simplest and conventional meaning of a smallholder is the case when the land available for a farmer is very limited (Chamberlin, 2008 and Hazell et al., 2007). However, the meaning goes far beyond this conventional definition and consists of some general characteristics that the so called small farms or smallholders generally exhibit. Chamberlin has identified four themes on the basis of which smallholders can be differentiated from others. These themes include landholding size, wealth, market orientation, and level of vulnerability to risk (Chamberlin, 2008). Accordingly, the smallholder is the one with limited land availability, poor-resource endowments, subsistence-oriented and highly vulnerable to risk. Nevertheless, the smallholder may or may not exhibit all these dimensions of smallness simultaneously.

It is also common to set numeric value as a way to define small farms. Hazell et al. (2007), note that some literature define small farms as "those with less than two hectares of crop land" while others define smallholders as those endowed with 'limited resources,' such as land, capital, skills and labor. Similarly, there are also those authors who often describe small farms in terms of the low technology they mostly use, their heavy dependence on household labor and their subsistence orientation. Generally small-scale farmers are farmers who have been adopting low-input, low-output, rainfed mixed farming with traditional technologies.

There is no clearly stated definition as to what constitutes a small farm in Ethiopia as it is the case in many developing countries too. However, it is well known that “small farmers in Ethiopia account for 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 output. The average land holding size of 1.18 hectares per farm household (CSA, 2007/08) in Ethiopia meets the conventional meaning of small farms (less than two hectares per household). Even far beyond that the smallholders in Ethiopia are known for their resource constraints such as capital, inputs and technology; their heavy dependence on household labor; their subsistence orientation; and their exposure to risk such as reduced yields, crop failure and low prices (Betre, 2006; Mahelet, 2007).

In this study, the largest land holding size is found to be 3.5 hectares. All sample households in this study are treated as smallholders even though very few respondents exceeded the conventional two hectares ceiling for small farms. The main justification for this is that these households generally fulfill the other dimensions of smallness; that is, limited access to resources such as capital, technology; ownership of fragmented land; high exposure to risk; and subsistence orientation.

Participation: the act of involvement in some activities.

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

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

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

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

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

2.2 Theoretical Literature Review

2.2.1 History of Irrigation Development

Irrigation is a very old practice in the world. It is an old human activity and been practiced in some parts of the world for several thousand years. Rice has been grown under irrigation in India and Far East for nearly 5000 years. The Nile valley in Egypt and the plain of Tigris and Euphrates in Iraq were under irrigation for 4000 years (Peter, 1997).

Irrigation has formed the foundation of civilization in numerous regions for millennia. Egyptians have depended on the Nile's flooding of the delta for years; this may well be the longest period of continuous irrigation on a large scale. Mesopotamia, the land between the Tigris and Euphrates, was the bread basket for the Sumerian Empire. This civilization managed a highly developed, centrally controlled irrigation system. In that same time frame, irrigation apparently developed in present day China and in Indus basin (Schilfgaarde, 1994).

Irrigation has long played a key role in feeding expanding populations and is undoubtedly destined to play a still greater role in the future. It not only raises the yields of specific crops, but also prolongs the effective crop growing period in area with dry seasons, thus permitting multiple cropping (two or three and sometimes four crops per year) where only a single crop could be grown. Moreover, with the security provided by irrigation, additional inputs needed to intensify production such as pest control, fertilizer, improved varieties and better tillage become economically feasible. Irrigation reduces the risk of these expensive inputs being wasted by crop failure resulting from lack of water (FAO, 1997).

According to FAO (1997) 30-40 percent of world food production comes from an estimated 260 million ha of irrigated land or one–sixth of the world’s farmlands. Irrigated farms produce higher yield for most crops. FAO (2001) also reports that the role of irrigation in addressing food insecurity problem and in achieving agricultural growth at global level is well established. Cleary irrigation can and should play an important role in raising and stabilizing food production especially in the less developed parts of Africa of the Sahara.

2.2.2 Status of Irrigation Development in Africa

There is growing concern about food security in Africa and especially in Sub-Saharan Africa. While the aggregate global food supply/demand picture is relatively good, there will be a worsening in food security in Sub-Saharan Africa and cereal imports are projected to triple between 1990 and 2020; imports for which the region will not be able to pay. Africa is the driest continent (apart from Australia) and suffers the most unstable rainfall regime (FAO, 1997).

Droughts are frequent in most African countries and each year more people are at risk from the effects of inevitable droughts of greater or lesser severity. Furthermore, Africa's water resources are relatively less developed than those in other regions.

Agricultural productivity per capita in Sub-Saharan Africa has not kept pace with population growth, and the region is now in a worse position nutritionally than it was 30 years ago. Food production has achieved a growth of about 2.5 percent per year, while population has risen at a rate of an average 2.6 percent per year**.** In the past, additional food in Africa came from increase in the area cultivated, but as a good land becomes less available, the region will be forced to increase yields through the use of irrigation and other modern technologies. Both rain-fed and irrigated agriculture will need to be intensified, but irrigated agriculture has a higher potential for intensification (FAO, 1997).

In Sub-Saharan Africa, only about 10 percent of the agricultural productions come from irrigated land. Trends in irrigated land expansion over the last 30 years show that, on the average, irrigation in Africa increased at a rate of 1.2 percent per year; this rate began to fall in the mid-1980s and is now below 1 percent per year, but varies widely from country to country.

The total irrigated land of Africa is estimated to be 124 million ha. This figure includes all the land where water is supplied for the purpose of crop production. It represents an average of 7.5 percent of arable land (FAO, 1995).

2.2.3 Brief History of irrigation development in Ethiopia

Traditional irrigation is very old in Ethiopia. The traditional small-scale schemes are, in general, simple river diversions it is practiced in Ethiopia since ancient times producing subsistence food crops. However, modern irrigation systems were started in the 1960s with the objective of producing industrial crops in Awash Valley. Private concessionaires who operated farms for growing commercial crops such as cotton, sugarcane and horticultural crops started the first formal irrigation schemes in the late 1950s in the upper and lower Awash Valley. In the 1960s, irrigated agriculture was expanded in all parts of the Awash Valley and in the Lower Rift Valley. The Awash Valley saw the biggest expansion in view of the water regulation afforded by the construction of the Koka dam and reservoir that regulated flows with benefits of flood control, hydropower and assured irrigation water supply. The potential of irrigation water in Ethiopia is quite high and its drainage pattern is of great importance to its neighboring countries. From the total run off 110 billion m^3 about 90% flows down to neighbors through eleven major rivers. Traditional irrigation is very old in Ethiopia. These traditional small scale irrigation schemes are in general simple river diversions which are subject to frequent damage by flood. From the total potential area, the area irrigated is low and the reasons on the past regime is due to lack of fund, data on different factors of natural resources, infrastructure, skill, research and suitable policy and hydro-politics of the region.

For much of the lifetime of the Derg, very little attention was paid to small-scale and traditional irrigation schemes constructed and managed by peasant farmers. With the nationalization of industrial and agricultural 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 Derg began to show interest in small-scale water management schemes. The establishment of the Irrigation Development Department (IDD) within MoA at the end of 1984, a body entrusted with the development of small-scale irrigation projects for the benefit of peasant farmers, signaled a new approach to water development by the military government. However, progress was slow. From the mid 1980s to 1991, IDD was able to construct some 35 small schemes, of which nearly one-third was formerly traditional schemes used by peasants (MoA, 1993; Desalegn, 1999).

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 1984, the division was separated from SWCD and upgraded to IDD. In 1987, the activities of MoA were being decentralized to zonal offices, and IDD staffs were being transferred to strengthen the capacity of the zones. However, 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 was dissolved and its 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). Under the new arrangements, responsibility for irrigation development was given to the Bureau of Water, Minerals, Energy Resources Development (BWMERD) while MoWR has an overall policy, planning and regulatory role in respect to water resource development (JICA, and OIDA, 2001).

2.2.4 Necessity and access of irrigation water in Ethiopia

Ethiopia is a tropical country with a vast diversity of climate, topography and vegetation. Rainfall varies considerably in its place of occurrence, as well as in its amount. Crops cannot, therefore, be raised successfully throughout the nation due to recurrent drought, over the entire land, without ensuring artificial irrigation of fields.

Though Ethiopia's agriculture is dependent on climatic factors. Mainly conditioned by the availability of rainfall, there exist abundant water resources, which have a tremendous irrigation potential. Water is essential for human consumption, sanitation, production of food, and for the production of many industrial goods and raw materials. The need to develop water resources on a suitable basis emanated from a number of reasons in Ethiopia including rapid population growth, to increase food supply, expansion of industrial and other sectors, which demand more and reliable water. Especially in the agricultural sector in Ethiopia, water is the most limiting factor for the agricultural production even if there are twelve major surface drainage basins. Considering the erratic nature of rainfall, it is important to harvest or divert the rain or water from rivers to improve food production. As cited MoWE (2011), the land potential for irrigated agriculture is currently estimated at 4.5 million hectares, of which only 0.16 million ha or about 5% of the total irrigable land is under irrigation**.** Ethiopia is described as the water tower of the region and it is the main source of the Nile waters and more than 86% of the water of Nile originates from Ethiopia (FAO, 1976). Now a day Ethiopian government starts to utilize the potential water resource of the country for irrigation and hydro-power purpose. For example, on the current takes as burning issues are construction of the Nile river for hydro-power to create 5250MW (the name called renaissance dam) and this resource after finalize the project starts to satisfy the need of power of Ethiopian people and by selling the power to neighboring regions, then the country earns foreign currency, this currency (income) also uses for poverty reduction purpose, strengthen the economic power and gone the country for development.

2.2.5 Ethiopian water potential for Irrigation Development

In Ethiopia, In addition to surface water there is a further 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 ha (5% of the potential) is actually irrigated land under full irrigation in Ethiopia (MoWE, 2011). However, 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).

There is little information on the extent to which the so far developed irrigation schemes have been effective in meeting their stated objectives by improving their households income attaining food self-sufficiency and eradicating poverty (Abonesh et al., 2006). Therefore, currently, the government is giving more emphasis to the sub-sector by way of enhancing the food security situation in the country. Efforts are being made to involve farmers progressively in various aspects of management 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 irrigated agriculture.

Ethiopia cannot meet its large food deficits through rain-fed agricultural production alone. Cognizant to this fact, the government has taken initiatives towards developing irrigation schemes of various scales. This will continue and be further strengthened during the coming years. Now on the EPRDF regime starts to focus expansion of irrigated land and uses the potential of irrigation water sources. Therefore, careful planning and management of this precious resource is inevitable for the overall development of Ethiopia economy.

2.2.6 Classification of Irrigation Developments in Ethiopia

According to the Ministry of Water Resource (2002), irrigation development in Ethiopia is classified using two systems. The first classification system uses the size of command area irrigated as follows:

- Small -Scale systems are those covering an irrigated area of less than 200 hectare, growing primarily subsistence crops. Small-scale irrigation schemes serve mainly to supplement rainfall and provide a greater degree of security to peasant farmers (McCornick et al, 2003). Examples of SSIs include household-based RWH, hand-dug wells, shallow wells, flooding (spate), individual household-based river diversions, pumping and other traditional methods;
- Medium scale irrigations are those extending between 200 hectares and 3000 hectares and produce a mix of subsistence cash crops.
- Large-scale schemes 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.

SSI schemes are the responsibility of the MoARD and regions, while MSI and LSI are the responsibility of the MoWR. Small-scale irrigation is widespread and has a vital role to play in Ethiopia. The success of small-scale systems is due to the fact that they are self managed and dedicated to the felt needs of local communities. Indeed, small-scale schemes are defined as schemes that are controlled and managed by users themselves (Taffa, 2002).

The second classification uses a mix of the history of establishment, time of establishment, management system and nature of the structures as follows:

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

- Modern schemes: These are SSI systems with more permanent diversion weirs made from concrete hence no need for annual reconstruction and small dams. The primary and sometimes secondary canals are made of concrete. They are community managed and have recently been constructed by government.
- Public: These are large scale operations constructed and managed by government. Sometimes, public schemes have out growers whose operations are partially supported by the large scheme.
- Private: These are privately owned systems that are usually highly intensive operations.

Traditional irrigation in Ethiopia is a complement to rain fed agriculture, and the crops grown are often horticultural crops and fruit trees. Peasants have a keen awareness of the benefits of irrigation and are willing to invest their labor in the construction and maintenance of the schemes. In parts of North Shoa, North Wollo, East Gojam and the highlands of Harrarge, the traditional systems still being utilized by peasants date back to the last century. Many of these schemes are managed by elected elders known as “water fathers” or “water judges” and this traditional management system has proved effective in many instances. In some cases, the irrigation schemes are managed by peasant associations. It is thus evident that peasants have proven ability to organize themselves and to manage traditional small scale irrigation systems (Dessalegn, 1999).

The development of modern irrigation has relatively recent history in Ethiopia, where as traditional irrigation has been in existence for long periods. Private concessionaires who operated farms for commercial cotton, sugar cane and horticultural crops started the first formal large and medium irrigation schemes in the Awash Valley (MoA, 1993).

2.2.7 Small Versus Large Scale Irrigation

With regards to operation, management and performance of large-scale irrigation schemes in Africa, FAO (1987) identified the following special weaknesses:

- Over sizing government and administrations, leading to excessive recurrent costs
- Lack of management and technical skills
- Lack of consistent policy and failure to plan for the medium and long term
- Political interference in technical and economic decision making and failure to delegate authority as well as responsibility
- Lack of foreign exchange for such essentials as fuel, spare parts and replacement machinery
- Failure to give adequate return to farmers, leading to their abandoning the schemes

Due to such problems in large-scale schemes, small-scale irrigation has been increasingly recognized as a valid and attractive option in irrigation development both by government and donor agencies.

In a more practical sense, small-scale irrigation developments are concentrated with the upgrading of traditional community irrigation or village irrigation systems, newly designed and constructed irrigation systems and ground water and pump development (Smith 1988). In highland areas like Ethiopia, where water is delivered through gravity, small-scale irrigation schemes concern the upgrading of irrigation works, where the simple diversion structures constructed by traditional communities with local means such as stone and brushwood have been replaced by small concrete or masonry weir, which divert water in a more effective and durable way. Such upgrading of irrigation works are the major functions of all river diversion irrigation projects that have been undertaken in different parts of Ethiopia.

An important aspect in the promotion of small-scale irrigation has been to increase farmers' involvement in the planning, implementation, operation and management of irrigation systems. The participation of farmers as direct beneficiaries in the construction of the schemes and their responsibility in the operation and management could considerably reduce development and management costs and improves performance. A study conducted on the socio-economic impact of ten smallholders' irrigation schemes in Zimbabwe (FAO 2000) reported that projects that are planned with farmer participation perform better than that are planned by experts on their own.

The study further noted that projects that are viewed by farmers as being their projects perform better than projects that are viewed by them as belonging to the government.

According to the Ministry of Water Resource (2002) the main advantages of small-scale irrigation schemes are:

- Much lower investment costs, and in a majority of cases these costs are borne by the community
- Do not involve dams or storage reservoirs, hence no population displacement is involved
- Less demanding in terms of management, operation and maintenance
- No land tenure or resettlement implications
- No serious adverse environmental impact
- Allow a wider diffusion of irrigation benefits and permit farmers to learn irrigation techniques at their own pace and in their own way.

2.2.8 The Ethiopian Irrigation Strategy

Ethiopia has a huge water resource potential to be utilized for irrigated agriculture and hydroelectric power generation. Since the 1950s large-scale irrigation scheme with mechanization of agricultural activities especially in Awash valley were under taken for the production of industrial crops (cotton, tobacco). But, from 1980s the significance of small-scale system was identified as a response to tackle the recurrent drought.

According to Haile (2008) Irrigation development is taken as one of the pillars of the plan for the modernization of the agriculture sector, which was conceptualized by the government of Ethiopia as the main instrument for operationalizing the Agricultural Development Led Industrialization (ADLI). This strategy gives a strong focus on increasing the agricultural productivity by addressing the problem of shortage of water through the introduction of irrigation development goals. In line with this objective, the Government of Ethiopia’s (GoE) policy towards irrigation management and development has been outlined in the Water

Resources Management Policy. This policy document issued in 1999, elaborates blueprint on the management of water supply, sanitation, irrigation and hydropower sectors. The overall goal of the Ethiopia Water Resource Management Policy is to enhance and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resources of the country, to ensure significant socioeconomic development on a sustainable basis.

The specific objectives of the policy are to: (i) promote the development of the water resources of the country for economic and social benefits of the people, on an equitable and sustainable basis;(ii) allocate and appropriately apportion the water, based on comprehensive and integrated plans, and optimize the allocation principles that incorporate efficiency of use, equity of access, and sustainability of resources; (iii) Manage and combat drought as well as other drought associated impacts, and disasters through efficient allocation, redistribution, transfer, storage and efficient use of water resources; and (iv) conserve, protect and enhance water resources and the overall aquatic environment on a sustainable basis. The general policies to irrigation sub-sector are: to

- Ensure the full integration of irrigation with the overall framework of the country's socioeconomic development plans, with particularly reference to the Agricultural Development Led Industrialization (ADLI) Strategy.
- Promote the development of irrigation based on strong strategic planning to achieve the socioeconomic goals and participatory approach for promoting efficiency and sustainability.
- Develop irrigation within the framework of the overall water resources management policy.
- Allocate a reasonable share of annual GDP for irrigation development.
- Promote decentralization and user-based management with a special emphasis to the needs of rural women's participation.
- Develop a hierarchy of schemes on the basis of achieving food self sufficiency and production of industrial raw materials.
- Support and modernize traditional irrigation methods by providing inputs that would improve their efficiency and sustainability.

- Protect and maintain acceptable water quality standards for irrigation.
- Develop water allocation and priority setting criteria.
- Integrate the provision of appropriate drainage facilities as an integral operating procedure of the irrigation infrastructure.

The policy recognizes and adopts the hydrologic boundary or "basin" as the fundamental planning unit and water resource domain. It also describes policy on a variety crosscutting issues which include groundwater resources management, watershed management, water-rights allocation, full involvement and participation of all stakeholders in all phases of the project, developing various norms, and procedures and guidelines in regards to financial sustainability. Furthermore, the promotion of credit and cost recovery mechanisms as well as institutional capacity building and improvement in productivity, development of appropriate and affordable designs and technologies technical guides, standards and design manuals are consider in the policy. Finally cohesive effort and goal setting has been identified to mitigate the negative environmental impacts.

2.3 Empirical Literature Review

In this section some studies that deal with small-scale irrigation participation decision and its effect on income are reviewed. Literature that examines the effect of irrigation on agricultural performance, uni dimensional poverty and household income is mixed.

Rosegrant and Everson (1992) found that they were unable to establish a positive link between irrigation investment and productivity in India. Similarly, study done by Jin et al. (2002) also did not find a link between irrigation and the total factor productivity growth of any major grain crop in China between 1981 and 1995. Empirical study conducted by Berhanu and Pender (2002) in Tigray Region, Ethiopia, showed that the impacts of irrigation development on input use and the productivity of farming practices controlling all other factors were insignificant. They indicted that irrigation has limited impact on the use of fertilizer and improved seed leading to less gain productivity from irrigation. However, they suggested the reason why irrigation failed to improve productivity of farming practices, deserved further and careful study on the technical, institutional, governance and managerial aspects.

A study undertaken by Narayanamoorthy (2001) in India using state wide cross section data covering the period 1970 to 1994 for fourteen major states of India, showed that besides increasing the cropping intensity and productivity of crops, the intensive cultivation of crops due to timely access to irrigation increased the demand for agricultural labourers and hence wage rates for those who lived below the poverty line.

Empirical evidence from Australia showed that a dollar worth of output generated in irrigated agriculture generates more than five dollars worth of value to the regional economy, which suggested irrigation development has a strong multiplier effect on other sectors of the economy (Ali and Pernia 2003).

FAO (1996) suggests that in developing countries irrigation can increase yields for most crops by 100 to 400%, while also allowing farmers to reap the economic benefits of growing higher value cash crops. Less risky, more continuous and higher, levels of rural employment and income (for both farm families and landless labourers) can result from irrigated as compared to rain fed agriculture. Increased productivity is also noted to have an effect in reducing overall food prices.

Binswanger and Quizon (1986) found that in India the effect of expanding irrigated area by 10% on the rural poor, resulted in an aggregate output increase by 2.7%, and a decreased in aggregate price level by 5.8%. With a secure water supply, farmers can choose to invest in higher-yielding seeds, grow higher-value crops, and harvest an additional crop or two each year. Irrigation also increased cropping intensity, farm income, and job opportunities for those that are landless rural poor. Investigations made by Chancellor and Hide (1997) at 12 small schemes in Kenya and Zimbabwe, showed that access to irrigation generally contributed 25–80% of total family income. Farmers appeared to have a reasonable standard of living and were able to cover the cost of school expenditures and health needs. In another Study conducted in Gambia, Zimbabwe, Tanzania and Kenya, women's access to irrigated land and control of the distribution of produce had a significant impact on overall family nutrition and income of female-headed households (IPTRID, 1999).

Moreover, Hussain and Hanjra (2003) and (2004) also found that the productivity of irrigated lands were twice that of non-irrigated reference areas, the net productivity benefits; defined as the difference in net output values between irrigated and non irrigated lands varied widely across settings from US$23 to US$600 per hectare. They argued that a range of factors influence the net productivity benefits of irrigation, and categorized these factors as: (a) farm level factors (i.e. crop yield differences, differences in production methods and technologies; land quality, types of cropping patterns, the degree of diversification towards high value crops and other farm enterprises; and farmers' access to support measures such as information, input and output marketing); (b) system level factors (i.e. condition of irrigation infrastructure and its management/maintenance, irrigation water allocation and distribution procedures and practices and related institutions); and (c) related policies (i.e. policies that influence land distribution patterns).

A study conducted by Francois et al. (2003), indicted that 4 micro dams and 2 river diversions irrigation projects in Tigray have been successful in enabling farmers to obtain a certain amount of wealth suggesting that farmers involved in irrigation schemes have shown significant improvement in their livelihoods, and earn higher incomes than non irrigation users. The assessment further illustrates these beneficiary households to be able to produce enough for the year round household consumption, build household assets such as different livestock, and build better improved houses which directly mitigate vulnerability to shocks. They also stated that irrigation offers the rural population an alternative source of employment and income. The assessment concluded that the use of the irrigation schemes improved the livelihood of the beneficiaries and recommended the expansion of similar projects to the other regions.

Similarly, a study made by Lire (2005) in eight public managed micro dams and 29 surrounding villages in Tigray, Ethiopia showed that agricultural yield and farm profit have significantly increased in villages with closer proximity to the dams than in those further away from the dam water resource. According to the study the overall evidence suggests that carefully designed irrigation dams could significantly improve agricultural production and overall food security.

Irrigation not only contributes to increased crop production but may also reduce variability in production through improved control of the crop environment. In this respect an empirical study done in Nigeria showed that the proportions of population of irrigation beneficiaries that experienced crop failure and poor harvest dramatically declined in comparison to the pre-irrigation status (Babatunde, 2006)

Ray et al (1988, cited in Lipton et al., 2003) indicted that, in comparison to non irrigated conditions, the expansion of irrigation has contributed to a substantial improvement in reducing instability in the output of food grains as well as of other crops. Because of this, the poor are less likely to need to borrow to increase consumption levels and so avoid the high capital market access costs that they usually face when borrowing. In addition, less risky production of staples or other crops allows them to take more risks with other activities, encouraging diversification into higher risk but potentially higher income activities, such as cash crops for export or new nonfarm activities.

Yield enhancing inputs such as fertilizers are highly complementary with water and hence the demand for these inputs is influenced by availability of water. A study made by Madhusuda et al. (2002) in India indicated that availability and access to irrigation infrastructure coupled with the availability and access to new technologies high yielding varieties and fertilizers were major underlying factors for the success of the green revolution in India. They noted that better access to irrigation has facilitated intensification of cropping practices and inputs used, and contributed to the “modernization” of the agricultural sector.

The other commonly cited area that related with irrigation is the creation of additional rural labour employment. Since irrigation requires labour, labour employment and real wages rise with the introduction of irrigation. Chambers (1988) showed that irrigation raises employment by increasing the number of days of work per hectare, per crop season and per crop year. He further noted that irrigation induced employment increases help to smooth seasonal troughs in agricultural employment and improve and stabilize wage rates for agricultural labourers. Lipton et al. (2003) argued that there are three sources of additional demand for labour created by irrigation. The first is irrigation facilities require labour for their construction and maintenance of irrigation infrastructure. Secondly, increases in multiple cropping (both dry and wet season cultivation), cropping intensity, and crop diversification as a result of access to irrigation also motivate higher farm labour employment, in migration and higher wage rates. They also stated that access to irrigation created additional labour by promoting nonfarm rural output and employment. Chambers (1988) also cited several empirical studies across countries that show irrigation directly raises employment for landless labourers via increase in days worked per hectare, day worked per a cropping season, and additional employment in a second or third irrigation season. This increase in demand for labour has a direct effect on increasing wage rates. By creating more secure and stable rural communities, access to irrigation water can also help stop the tide of migration to already overcrowded cities and slums (van Hofwegen and Svendsen, 2000, Chambers, 1988).

This evidence was also supported by a study conducted by Hussein et al. (2002) in Sri Lanka and Pakistan. They found that labour employment per hectare and wage rate were found to be significantly higher in irrigated settings than in non-irrigated settings. Furthermore, a study conducted by Hussein and Hanjra (2003) in south and south east Asia found that higher labour employment and wage rates were reported in irrigated than rainfed areas, and they concluded that this change in wage was a direct result of irrigation development. Furthermore, they provide evidence on the significant contribution of irrigation to employment generation in agriculture. They noted that the annual labour work per hectare in the Ganges-Kobadak irrigation system of Bangladesh was around 100 days more than that in nearby non irrigated areas. This additional labour demand has creates better full time employment opportunities for farm family members and also create employment opportunity for hired labour. Moreover, they indicted that hired labour used in irrigated settings was double compared to that of nearby non irrigated areas and the wage rate was 15% higher in the former than in the latter areas. Qiuqiong et al. (2005) argued that the green revolution in Asia would not have happened without massive irrigation development. Without more irrigation many countries would have been unable to achieve the agricultural and economic growth rates required to achieve food security and reduce poverty.

They stated that irrigation has been tremendously effective in generating a variety of benefits such as improvements in productivity, employment, wages, incomes and consumption expenditures.
Another important issue in the income irrigation casual relationship is the issue of choice between small-scale versus large-scale irrigation systems. According to FAO (1986 as cited in Rahmato, 1999) small and indigenous irrigation schemes are the dominant form of irrigation in much of Sub-Saharan Africa that could play important role addressing drought and food insecurity. However the development programmes in Africa have not given sufficient attention to the small-scale and indigenous based irrigation technologies. Van Koppen (1998) stated that small scale irrigation schemes given their dispersed nature, and relatively small size, suitability for households under resource poor conditions, small scale water harvesting are not likely to attract significant external support. However, she argued that small scale irrigation scheme do offer considerable potential for income improvement and equitable resource access.

The FAO (1999) pointed out that many Sub-Saharan countries have realized the critical role of irrigation in food production. However, the relatively high cost of irrigation development combined with the inadequate physical infrastructure and markets access, poor investments in irrigation, lack of access to improved irrigation technologies, and lack of affordable and readily available water supplies, have been responsible constraints for a relatively slow rate of irrigation development in this region. FAO further identified fragmented and small land holding, unsecured or lack of land titles, high interest rates, and poor transportation and marketing facilities as further constraints affecting the capacity of farmers to invest and manage irrigation projects.

Kumar (2003) also stated that irrigation has contributed significantly in boosting India's food production and creating grain surpluses used as drought buffer. A study by Hussain et al. (2004) confirms that, access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities; both on farm and off farm and can improve incomes, livelihood, and the quality of life in rural areas. Hussain et al. (2004) identified five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare. The same study in Sri Lanka reported that irrigation development has been a major instrument used by the government in its attempt to enhance food security and eradicate poverty for over 5 decades.

Ngigi (2002) disclosed that for the two decades in Kenya agricultural production has not been able to keep pace with the increasing population. To address this challenge the biggest potential for increasing agricultural production lies in the development of irrigation. According to the same study, irrigation can assist in agricultural diversification, enhance food self sufficiency, increase rural incomes, generate foreign exchange and provide employment opportunity when and where water is a constraint. The major contributions of irrigation to the National economy are food security, employment creation, and foreign exchange. In Ethiopia a study conducted by Woldeab (2003) identified that in Tigray irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming.

A study by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions. According to this study, the cash generated from selling vegetables and other produce is commonly used to buy food to cover the household food demand during the food deficit months. The same study further added that during an interview conducted with some farmers, it was disclosed that the hungry months reduced from 6 to 2 months (July and August) because of the use of small scale irrigation. Moreover, the increase in diversity of crops across the schemes and the shift from cereal livestock system to cereal-vegetable-livestock system is starting to improve the diversity of household nutrition through making vegetables part of the daily diet.

CHAPTER THREE

3. RESEARCH METHODOLOGY

This section presents an overview of the study area description, the methods used for data collection and econometric models applied in the study. That is, it includes the data source and data collection methods, sample size and sampling techniques, methods of data analysis, econometric models apply for the study and definition of Variables and Working Hypotheses.

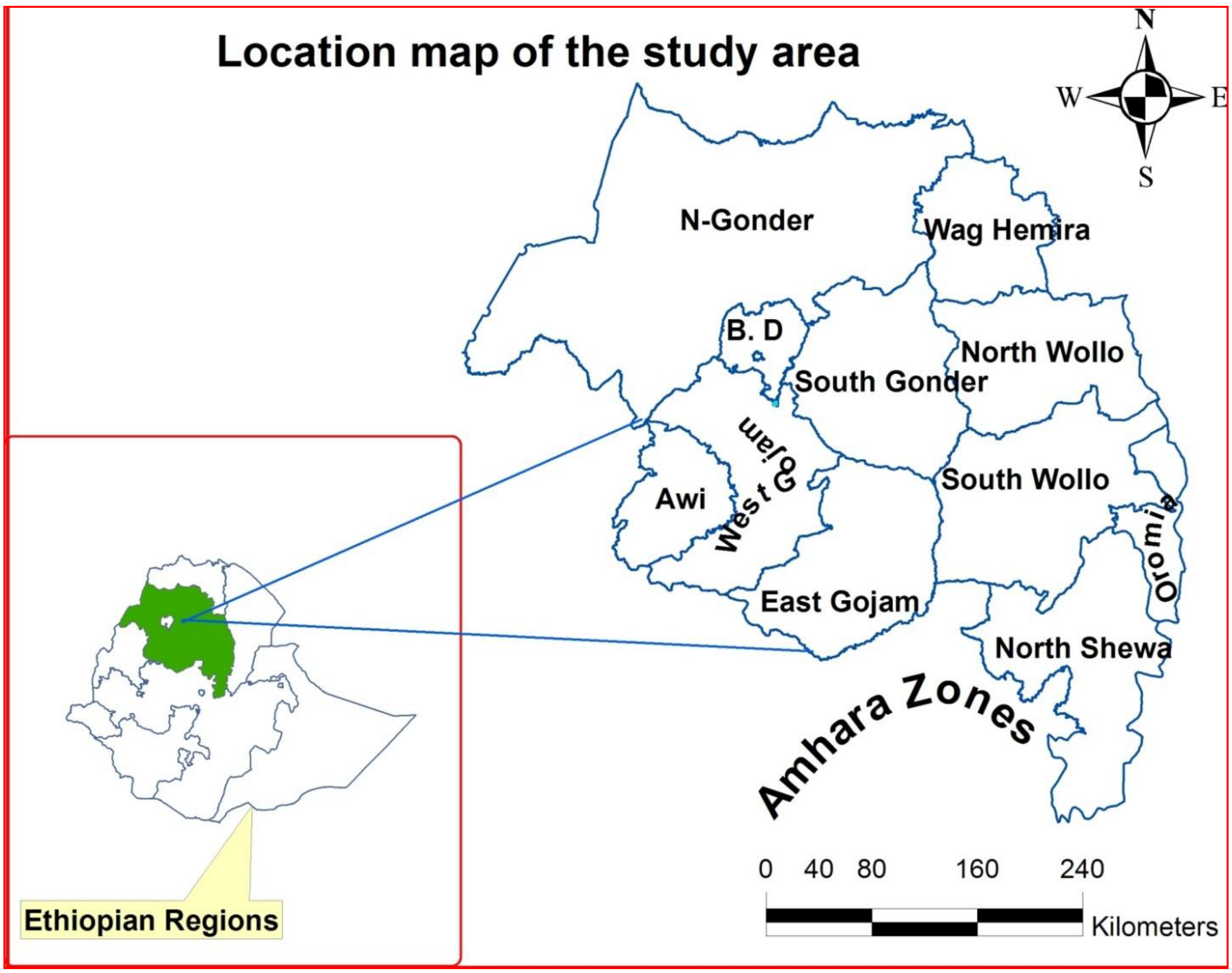
3.1 Description of the Study Area

3.1.1 Amhara National Regional State

The Amhara National Regional State (ANRS) is one of the states of the Federal Democratic Republic of Ethiopia. The ANRS is located in the Northwestern part of the country (Figure 1) between 8°45' and 13°45' North latitude and 35°45'and 40° 25' East longitudes. The boundaries of the ANRS adjoin Tigray in the North, Oromia in the South, Afar in the East, Benishangul Gumuz in the South West, and Sudan in the North West. The State is divided into 11 administrative zones, including the capital city of the region, Bahir Dar. The other 10 Administrative Zones are: East Gojam, West Gojam, Awi, North Gonder, South Gonder, Wag Himra, North Wollo, South Wollo, North Shewa, and Oromia. The region consists of 105 districts.

The total area of the region is 159,173.66 square kilometers. Topography is divided mainly into plains, mountains, valleys, and undulating lands. The high and mid-altitude areas (about, 65% of total areas) are characterized by a chain of mountains and a central plateau. The lowland part, constituting 33% of the total area, covers the Western and Eastern parts of the region; these are mainly plains that are large river drainage basins.

The population of the region was estimated to be 17,221,976 in 2007 of whom 8,641,580 were men and 8,580,396 women; urban inhabitants number 2,112,595 or 12.27% of the population. With an estimated area of 159,173.66 square kilometers, this region has an estimated density of 108.2 people per square kilometer. For the entire Region 3,983,768 households were counted, which results in an average for the Region of 4.3 persons to a household, with urban households having on average 3.3 and rural households 4.5 people(CSA, 2007). A large proportion of the population in ANRS depends up on crop and livestock farming. Cropping systems are predominantly rain-fed. Because of population pressure and poor land husbandry, the level of land degradation and environmental depletion is worsening over time.



Source: Bureau of Finance & Economic Development

Figure 1 Administrative map of Amhara region

3.1.2 North Gondar Administrative Zone

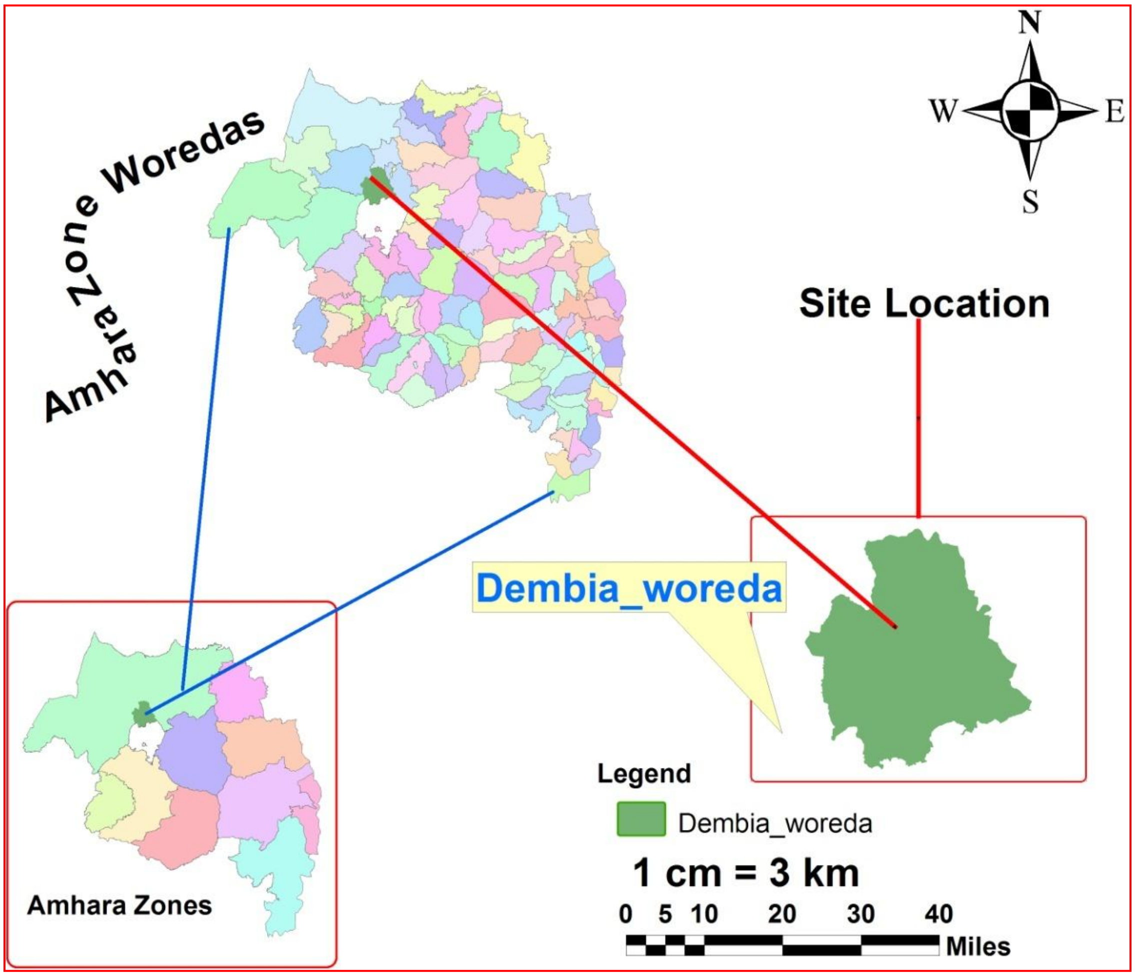
The study was conducted in North Gondar Zone, Amhara National Regional State. The Zone is located in the north –western part of the country between 11°56′ and 13°45′ North latitude and 35°11′ and 35°50′East longitudes 738 Km. far from Addis Ababa. The zonal capital is Gondar city and geographically, the city is located at 12°36′N latitude and 37°28′E longitudes with average elevation of 2133 meters above sea level. The zone is dominated by the agricultural sector, which employs about 90 percent of the working force. The zone is divided into 18 woredas of which one is urban and 546 kebeles. The boundaries of the Zone adjoin Tigray region in the North, Awi Zone and West Gojam Zone in the South, Waghimra Zone and South Gondar Zone in the East and the Sudan in the West. The total area of the Administrative Zone is 50,970 square kms. Most of it is located in the North Central massif area of the highlands. In striking contrast to the central massif are the lowlands located in the western region of North Gondar Zone along the border of Sudan characterized by higher temperatures and fragile soils. The low lands contain some of the largest tracts of semi-arid natural forest remaining in Northern Ethiopia. According to the 2007 census conducted by the central statistical agency of Ethiopia (CSA), this zone has a total population of 2,921,470(2,457,645 rural and 463,825 urban) of which 1,481,726 are men and 1,439,744 are women. The population density is 54.11 persons per square km.

The farming system of the study area is largely characterized by crop-livestock production system (mixed farming systems). According to 2003 report of Central Agricultural Census Commission, of the total agricultural holders reported in the region, the second largest number of agricultural holders next to South Wollo Zone (16.3%) was found in North Gondar Zone (14.3 %). Out of the total rural agricultural holders those who are engaged in crop production, livestock and both crop and livestock productions were estimated to be 16.07 %, 8.58 % and 75.35 %, respectively. As far as the employment status of population engaged in agricultural activities, about 72 percent of the population agricultural households' age 10 years and over was fully engaged in agricultural activities, while only 26.2 percent of the population was partially engaged in agricultural activities. The proportion of population engaged in nonagricultural activities only was negligible, amounting to 1.8 percent. Of the total land area recorded in the region, the largest area is contributed by the Zone (29.85 %). The total land holding area under different land uses was estimated to be about 570,160 hectares, in the zone. Of this land, area under annual crops accounted for 507,474 hectares (89%), land under permanent crops was estimated to be 2,347 hectares (0.4 %); grazing land amounted to be 12,312 hectares (2.2 %); fallow land is reported to be 37, 274 hectares (6.5 %); wood land amounted to be 441 hectares (0.1 %) and land for other uses is estimated to be 10,311 hectares (1.8 %). The average size of land holdings was 1.29 hectares. Livestock are also important in the farming system of the Zone. They serve as a source of draught power, transport, income, food, fuel and manure. The major animal species kept in the study areas are cattle, goats, sheep, and equine.

The altitude of the Zone ranges from 4620 meters in the semen mountain in the North to 550 meters in the western parts of the study area and rainfall varies from 880 mm to 1772 mm with the maximum temperature of $44.5°c$ in the west and minimum temperature of $-10°c$ in the highland. The area is also characterized by two seasons, the wet season, from June to September and the dry season from October to May. The survey will be conducted in one rural woreda of North Gondar zone which is Dembia woreda.

Dembia woreda is located at $37°26'$ E longitude and $12°17'$ N latitude. The woreda capital, Koladiba, is located 750 km North of Addis Ababa and 35 km southwest of the zonal capital, Gondar. The woreda shares borders with Gondar town and Lay Armachiho in the North, Gondar Zuria Woreda in the east, Chilga and Alefa woredas in the west and part of Lake Tana in the south. Total area of the woreda is 1490 km2 with 45 kebeles (of which five are urban centers). According to 2007 census, the Woreda has total 270,994 (247,643 rural and 23,351 urban) population. The total population can be disaggregated by gender as follows, rural: male 127,361, female 120,282; urban: male 10,724, female 12,627. The Woreda have a total of 49,528 rural households with five mean household size. The altitude of the of the woreda ranges from 1790 and 2600 meter above sea level. The agro ecology of the woreda is temperate (Woinadega) with mean annual minimum and maximum temperature of $11℃$ and $32℃$ respectively and the mean annual rain fall ranges from 995 to 1175mm.

In the woreda, various land use patterns are recognized. According to the information gathered from the woreda ARDO, out of the total area of about 150 thousand ha, 33% is used for annual crop production, 13% for grazing, 6% for forest plantation, bush and shrubs, 16% is degraded (unproductive) and the residential areas constitute about 4%.The woreda receives bimodal rain fall, with short rains from March to May and long rains from June to September (DOARD, 2013).



Source: Bureau of Finance & Economic Development

Figure 2 Zone and Woreda in which the study site are located

3.2 Data Source and Data Collection Methods

For this study both primary and secondary sources have been gathered and analyzed to collect both quantitative and qualitative data. The conventional household survey was the main method used to collect quantitative primary information through a carefully designed structured interview schedule which was prepared for the study. Information pertaining to households' demographic, socio-economic characteristics and institutional situations etc. were obtained directly through the interview and sample household heads were the unit of analysis. Three enumerators in each sampled kebeles were employed to conduct the survey under the close supervision of the researcher. The enumerators were development agents in each kebeles. Development agents were chosen as enumerators due to their knowledge and acceptance among the community that helped the researcher get the questionnaire filled properly. Appropriate training, including field practice, were given to the enumerators to develop their understanding regarding the objectives of the study, the content of the questionnaire, how to approach the respondents and conduct the interview. Pre-testing of the questionnaire was carried out with the enumerators and depending on the results, some adjustments have been made to the final version of the questionnaire and proper data collection was started with the day to day supervision of the researcher. Focus group discussion, key informant interview and direct personal observation were also used to collect qualitative primary data. My personal observation of the site helped me to understand the over-all process of irrigation development and crosscheck data gathered through household survey and key informant interview. In addition to primary data, secondary data that could supplement the primary data were collected from published and unpublished documents, District and Zonal Offices of Irrigation Development (OID), District and Zonal Offices of Agricultural and Rural Development (OARD), District and Zonal Offices of Finance and Economic Development (OFED), are some of the offices from which secondary data were obtained.

3.3 Sample Size and Sampling Method

In this study, three stage sampling procedure was adopted for the selection of sample respondents. In the first stage, out of 18 woredas under the current administrative structure in North Gondar Zone, Dembia woreda was selected purposively because of its irrigation potential. There are three woredas in North Gondar Zone which are known for their irrigation potential. These are: Dembia, Gondar Zuria, and Lay-Armachiho in descending order by their irrigation potential. In the second stage, out of 40 rural kebeles that are found in Dembia woreda, five kebeles were purposively selected on the basis of their irrigation potentials and accessibility. In the third stage, first the household heads in the five sample kebeles were identified and stratified in to two strata: irrigation user and non -user. The lists of total households in the selected Kebeles and the lists of irrigation user households in these Kebeles were obtained from District Office of Finance and Economic Development and District Office of Irrigation Development respectively. The non-users were selected within Kebeles of irrigation users to ensure homogeneity of factors except irrigation. Then the sample respondents from each stratum were selected using simple random sampling technique. Total sample of 240 rural households, 112 households from irrigation non-user and 128 irrigation user households have been drawn by taking in to account probability proportional to size of the identified households in each of the five selected kebeles.

Table 1: Summary lists of selected Kebeles from the study wereda

Serial Number	Name of Kebele	Name of Woreda
1.	Sufankara	Dembia
2.	Guramba Michael	Dembia
3.	Atekelt Telefet	Dembia
4.	Tana Woina	Dembia
5.	Abredgeha	Dembia

3.4 Methods of Data Analysis

3.4.1 Descriptive Statistics

Descriptive statistics is one of the techniques used to summarize information (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 etc. one can compare and contrast different categories of sample units (in this case farm households) with respect to the desired characters so as to draw some important conclusions.

3.4.2 Econometric Model

Regression models in which the regressand evokes 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 census-type data (Gujarati, 2004; Verbeek, 2004; Green, 2003; Woodridge, 2002). One of the dependent variables in this study is also a dummy variable, which takes a value of zero or one depending on whether or not the households participate in small-scale irrigation. However, the independent variables are of both types that are continuous or categorical.

When one or more of the explanatory variables in a regression model are binary, we can represent them as dummy variables and proceed to analysis. However, the application of the linear regression model when the dependent variable is binary is more complex and/or even not efficient (Pindyck and Rubinfeld, 1981). Binary choice models assume that individuals are faced with a choice between two alternatives and their choice depends on their behavior. Thus, one purpose of a qualitative choice model is to determine the probability that an individual with a given set of attributes will make one choice.

Small-scale irrigation participation is a dependent variable, which is dichotomous taking on two values, one if the household participate in 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 (Aldrich and Nelson, 1984). The OLS regression technique, when the dependent variable is binary, produces parameter estimates that are inefficient and a heteroscedastic error results in the structure. 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, hetroscedastic variance of the disturbance, lower value of R^2 and nonsensical predictions that may generate predicted values outside the 0-1 interval, which violates one of the basic tenets of probability (Non fulfillment of $0 \leq E(Yi/Xi) \leq 1$). To alleviate these problems and produce relevant empirical outcomes, the most widely used qualitative response models are the logit and probit models (Amemiya, 1981).

The logit and probit models guarantee that the estimated probabilities will lie between the logical limit of 0 and 1.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).

Because 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 participation.

3.4.3 Heckman two-stage Procedure

However, the aim of this study is also to analyze the effect of small scale irrigation on household income. Because evaluating the effect of small scale irrigation on an outcome variable (income in this case) 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 or due to unobservable nature of the dependent variable for some observations. The reason for this is that, the effect of small scale irrigation may be over (under) estimated if small scale irrigation participants are more (less) able due to certain unobservable characteristics i.e. if household income of the irrigation participants is significantly higher than that of non participants 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.

To evaluate the effect of a program, a model commonly employed can be expressed as:

$$Y = X\beta + \alpha I + \mu \quad (1)$$

Where Y is the outcome/effect, X is a vector of personal exogenous characteristics and I is a dummy variable (I=1, if the individual participates in the program and 0 otherwise). From this model, the effect of the program is measured by the estimate of α. However, the dummy variable 'I' cannot be treated as exogenous if the likelihood of an individual to participate or not to participate in the program is based on an unobserved selection process or a combination of observable and unobservable factors (Maddala, 1983). Some studies have shown the limitations of applying the classical linear regression methodology to the analysis of samples with selectivity bias (Heckman, 1979, Dardis *et al*. 1994, Sigelman and Zeng, 1999, Maddala, 1992). Application of the classical linear regression model does not guarantee consistent and unbiased estimates of the parameter. One 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 view of the need to estimate the selection process in to the irrigation program, the Heckman two stage selection model were employed. This approach is chosen because it considers for selection bias that could arises due to unobservable factor. The common version of the Heckman procedure is to estimate in two stages. In the first stage, estimate the selection or participation equation (the probability of participating in small scale irrigation) using probit model and derives maximum likelihood estimates with data from both participants and nonparticipants, using the estimation result "Inverse Mills ratio" is constructed. The inverse Mills ratio (lambda) is the tool for controlling bias due to sample selection (Heckman1979). The second stage involves including the Inverse Mills ratio as an additional explanatory variable to the household income equation or outcome equation and estimating the equation using OLS model using data from the participant households only. If the coefficient of the 'selectivity' term is significant then the hypothesis that the participation equation is governed by an unobserved selection process or selectivity bias is confirmed. Moreover, with the inclusion of extra term, the coefficient in the second stage 'selectivity corrected' equation is unbiased (Zaman, 2001). Therefore, we are interested to apply Heckman's two stage model for this study since it simultaneously model the decision to participation in small-scale irrigation and the effect of small-scale irrigation schemes on the income of households.

3.4.4 General Specification of the Econometric Models Used for Analysis

In order to fulfill objectives one and two the following functional form is used.

$$Pi = f(Z_1, Z_2, Z_3, Z_4, \ldots Z_K) \quad (2)$$

The econometric model for the probit model stated in equation (2) can be specified as:

$$Pi = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \cdots + \alpha_K Z_K + \mu_i \quad (3)$$

Where,

Pi = dichotomous variable representing participation of smallholder farm households in small - scale irrigation; and it is equal to one if the household participates in small scale irrigation and zero otherwise. $Z_1.Z_2$, Z_3, Z_4,…Z_K are the vector of variables that affect smallholder farm households' decision to participate in small scale irrigation. Parameters; α_0 ,$\alpha_1, \alpha_3, \alpha_4 \ldots, \alpha_K$ represents coefficients for the row vectors to be estimated, and μ_i is the error term.

$$Y_i = f(X_1, X_2, X_3, X_4, \ldots X_K) \quad (4)$$

The econometric model for the outcome model stated in equation (4) can be specified as:

$$Yi = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_K X_K + \lambda + \varepsilon i \quad (5)$$

Where,

Y_i= represents the amount of income from small scale irrigation activities. X_1, X_2,X_3, X_4,…, X_K are determinants of smallholder farm households small scale irrigation income. Parameters; $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \ldots, \beta_K$ represent coefficients for the row vectors to be estimated, λ is the inverse mills ratio and εi is the error term with standard properties.

3.4.5 Specification of Heckman two-stage Model

The small scale irrigation income equation is present in equation (6).

$$yi = Xi\beta + \epsilon i \qquad (6)$$

Where yi is the individual household's income from small scale irrigation .It is observable for the participants and unobservable for the nonparticipant households that is why we use Heckman sample selection. X_i is a vector of observable factors that affect the level of income from small-scale irrigation and ϵi is the error term.

Let the selection model for household's participation in small scale irrigation be explained by the equation stated below. Here, the equation indicates that households participation depends on some value pi* of a latent variable.

$$pi^* = Zi\alpha + \mu i \qquad (7)$$

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

$$pi = \begin{cases} 1 \text{ if } pi^* > 0 \\ 0 \text{ if } pi^* \leq 0 \end{cases} \qquad (8)$$

With the decision to participate in small scale irrigation given by pi=1 if household participate and pi=0 otherwise, where pi is a variable indicates participation in small-scale irrigation, Z is a vector of variables that affect households' decision to participate and μ_i is the corresponding error term. The outcome equation (for our case income from small scale irrigation) is explained as:

$$yi = \begin{cases} Xi\beta + \epsilon i \text{ if } pi^* > 0 \\ \text{Unobservable if } pi^* \leq 0 \end{cases} \qquad (9)$$

As shown above, problems arise when estimating β if μi and ϵi are correlated. And further assuming that:

$$\mu i \sim N(0,1)$$

$$\epsilon i \sim N(0,\sigma 2)$$

$$\text{Corr}(\mu i, \epsilon i) = \rho$$

Put differently, the error terms (μi and ϵi are assumed to follow a bivariate normal distribution with mean 0, variances $\sigma\mu$ and $\sigma\epsilon$ respectively, and correlation coefficient ρ.The other assumption is (ε,u) is independent of X and Z i.e. the error terms are independent of both sets of explanatory variables.

The conditional expected income of individual households who participate in small scale irrigation becomes,

$$E\{yi/pi=1\} = Xi\beta + E(\epsilon i/pi \; =1\}$$

$$= Xi\beta + \frac{\rho\phi(Zi\alpha i)}{\Phi(Zi\alpha i)}$$

$$= Xi\beta + \rho\lambda$$

If the correlation coefficient ρ=0, estimating the model using OLS gives unbiased result. The term $\rho\phi(Zi\alpha i)/\Phi(Zi\alpha i)$is known as inverse Mill's ratio; usually represented by lambda (λ) and reflects for the selection variable that captures for selection bias.

Therefore, in our two stage choice context we simultaneously model participate in small scale irrigation and the effect of the irrigation schemes on household's income.

3.5 Definition of Variables and Working Hypotheses

Different variables are expected to affect households' participation decision and level of income from small scale irrigation in the study area. The variables hypothesized to affect participation in small scale irrigation and income are tested whether they are statistically significant or not using t-statistics and chi-square (χ 2) tests. The t-test is used to test the significance of the mean value of continuous variables of the two groups of users and non-users. Likewise the potential discrete (dummy) explanatory variables are tested using the chi-square (χ 2) distribution.

After the analytical procedure and its requirement are known, it is important to identify the potential explanatory variables and define its measurements as well as the symbol to represent them. Accordingly, the major variables expected to have influence on the participation decision to participate in small-scale irrigation and levels of income of households are explained in this section.

Dependent variables

For the heckman second stage analysis household income is a continuous variable measured in Birr. The dependent variable for the first stage of the heckman model is participation decision, which is a dummy variable taking a value one if the household participates in small scale irrigation and zero otherwise.

The independent variables that are hypothesized to affect the farmers' decision to participate in small scale irrigation and level of income are combined effects of various factors such as: demographic, socio-economic and institutional factors in which farmers operate are hypothesized to explain participation decision and level of income from small scale irrigation in the study area. Based on review of literatures on factors influencing participation in small scale irrigation and level of income, past research findings and the researcher's knowledge of the farming system of the study area, among the large number of factors which are expected to relate to farmers' participation decision behavior and income, the following potential explanatory variables are considered in this study and examined for their effect in farmers' participation decision of smallscale irrigation and level of income. These are presented as follows:

3.5.1 Demographic and Socio-Economic Variables

Access to Irrigation (acirrig): It is a dummy variable takes a value of 1 if the household participate in small-scale irrigation and 0 otherwise. Irrigation enables farmers to diversify and maximize agricultural production, practice multiple cropping, increasing cropping intensity and supplement moisture deficiency in agriculture. In doing so, it is assumed to have a direct relation with the total income of a household. Nhundu et al. (2010), Hussain and Biltonen, (2001) and Haile (2008) identified a strong positive relationship between access to irrigation and household income.

Distance from the nearest market (dismkt): It is measured in kilometer. It refers to the distance between the households' farm and the nearest market center. It shows access to the market to buy input and/or to sell output. As the farmer is nearer (closer) to a market, the higher will be the chance of participating in small-scale irrigation. It is also about securing information at market place. The farther the market center is the lesser the income from the sell of farm produce. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving the market and to avoid such incidences the farmer sells his output for cheaper price reducing the income. Therefore, distance from market is hypothesized to influence negatively the farmers' decision to participation in small-scale irrigation and income. The distance from the nearest market for each household in each sample kebeles were measured from the distance from the farmers'farm to Koladba which is the woreda capital and it is the nearest market for all sampled kebeles.

Level of Education of the household head (educ): Education has paramount impact on income improvement and poverty alleviation. It is likely that educated farmers would more readily adopt irrigation technologies and may be easier to train through extension support. This variable is a discrete: 0 if illiterate, 1 if informally literate, 2 if elementary(grade1-6)complete, 3 if Junior(grade 7&8) complete and 4 if high school and above(grade 9 and above). Household heads that are literate are expected to have a better knowledge of how to make a living. Literate household heads are very ambitious to get information and use it. Thus, it is hypothesized that household heads who are literate are more likely to use and benefit from small scale irrigation and expected to have a positive relationship with household income.

Distance from the water source (dishom): This variable is continuous and measured in kilometer. It refers to the distance between farmers' residence to the water source. Nearness of the households to irrigation scheme is expected to determine the household's participation decision in small scale irrigation positively.

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

Total livestock holding (livestock): This refers to 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 and then summing. Livestock is important source of income, food and draught power for crop cultivation in Ethiopian agriculture. More livestock holding is expected to increase the probability of participation in small scale irrigation. Livestock may also serve as a proxy for oxen ownership, which is important for farm operations. Therefore, in this study it is hypothesized that higher TLU will have positive influence on the participation in small scale irrigation and level of income particularly the owner of more oxen lead to an ability of ploughing more land on time, thereby achieving crop yields and earning higher income.

Soil fertility status (soilfert): It is a dummy variable which takes value 1 if the land is fertile and 0 otherwise. Here soil fertility is determined based on the response of the surveyed households. Fertility of land has direct relationship with productivity. 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 participation to small scale irrigation.

Size of cultivated land (cultland): This refers to the total cultivated land size (both irrigated and rain fed) 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 the 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).

Gender of the household head (sexhead): This is a dummy variable, which takes a value of 1 if the household is male and 0 otherwise. Male household heads are expected to have higher income compared to female household heads because of better labor inputs used in male-headed households than the female headed ones. Moreover, with regard to farming experience males are better than the female farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the small scale irrigation as early as possible and their income is higher than their counterpart.

Availability of family labor force (famlabor): In Ethiopia, as in most of other developing countries, labour is one of the most extensively used inputs of agricultural production. Adoption of new technology demands additional labour force for different farming operations. A household with large labor force can participate in small-scale irrigation more than a household with small number of labour force. Furthermore, Households with large family size will have more number of agricultural labors and hence, will have more agricultural production and more income provided that there is sufficient land to employ the existing labour. Therefore decision to participate in small-scale irrigation and income are directly related to the level of family labor availability. It is measured in terms of man-equivalent (see Appendix) and it is the active labour force the household owns.

Age of the household head (age) and Agesquare of the household head (agesquare): age is used to indicate the general experience of the household head. At younger ages the probability of participating in small scale irrigation will increase. But as the farmer gets older and older his managerial ability and physical capacity are expected to decrease as a result the overall labor hours will decline and the demand for leisure will increase. Hence, age and agesquare are hypothesized to have positive and negative effect on farmers‘decision to participate in small -scale irrigation and income level.

3.5.2 Institutional Factors

Access to credit facility (accredit): It is a dummy variable, which takes a value of 1 if the farm household had access to credit and 0 otherwise. Access to credit is an important source of investment. Those households who have access to credit have a better possibility of getting farm inputs. Therefore, it is hypothesized that access to credit determines farmers' decision to participate in small scale irrigation and income positively. According to Norton et al. (1970), credit helps farmers purchase inputs such as seeds, fertilizers and chemicals.

Access to extension service (acexten): It is a dummy variable, which takes a value of 1 if the farm household had access to extension service and 0 otherwise. Access to extension service widens the household's knowledge with regard to the use of improved variety and agricultural technologies. Since it is as an important source of information, knowledge and advice to smallholder farmers in Ethiopia. Therefore, access to extension service is hypothesized to have a positive relation with farm households' decision to participation in small scale irrigation and level of income.

Table 2: Summary of Variables included in the models

S.No.	Name of Variables	Symbol	Variable Type	Variables definition and measurements
1	Total income	totinc	continuous	birr
2	Access to Irrigation	acirrig	dummy	1if participated, 0 otherwise
3	Distance from the nearest market	dismkt	continuous	Km
4	Education level of household head	educ	dummy	0 if illiterate,1 informally literate, 2 grade1-6, 3 if grade 7&8 completed and 4 if grade 9 and above
5	Distance from the water source	dishom	continuous	Km
6	Access to information	acinfo	dummy	1 if has access,0 otherwise
7	Total livestock holding	livestock	continuous	TLU
8	Soil fertility status	soilfert	dummy	1 if fertile, 0 otherwise
9	Size of cultivated land	cultland	continuous	hectare
10	Gender of household head	sexhead	dummy	1 if male, 0 otherwise
11	Availability of family labor force	famlabor	continuous	number
12	Age of household head	age	continuous	years
13	Agesquare of household head	agesquare	continuous	years
14	Access to credit facility	accredit	dummy	1 if there is access,0 otherwise
15	Access to extension service	acexten	dummy	1 if there is access,0 otherwise

CHAPTER FOUR

4. RESULTS AND DISCUSSION

This chapter presents the results from the descriptive and econometric analyses. 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 participation and income and finally to measure the relative importance of significant explanatory variables on participation in small-scale irrigation and income.

4.1 Results of Descriptive Statistics Analysis

The descriptive statistics was run to observe the distribution of the independent variables. The socio-economic and institutional characteristics of the respondents such as availability of family labor force, age, sex, level of education, land holding, access to information, livestock holding, total income, access to credit, perception about soil fertility, access to extension service, distance from home to the water source, distance from the nearest market etc. of users and non- users of small-scale irrigation were analyzed. Of the total sample respondents interviewed 128 were found to be users of small-scale irrigation while 112 were non-users. These were 53.33 and 46.67 percents of the total sample, respectively.

4.1.1 Socioeconomic and Institutional Characteristics of Sample Households

Sample households were composed of both male and female household heads. Gender of the household head is an important variable influencing the participation decision in irrigation. It was found that among the total sample household heads 80% of them are male headed while 20% are female headed households. When we see the comparison by access to irrigation, out of the 128 irrigation user households 3.91% are headed by female and the remaining 96.09% is by male headed household. The corresponding figure for non users is 38.39% and 61.61% by female and male household heads respectively. Discussion with sample households revealed that male-headed households hardly faced labor shortage for irrigation as well as rain-fed farming due to physical, technological, socio-cultural and psychological fitness of farm instruments to males than females. The gender difference of household heads in irrigation participation and income indicated female-headed households face shortage of labor and market information, made them rent/share out their land to the male headed household heads. As a result the likelihood of participation and income of female headed household heads are less than the male headed household heads. The chi-square test of sex distribution between the two groups was run and the difference was found to be statistically significant at 1% level of significance.

Education plays a key role for household decision in technology adoption. It creates awareness and helps for better innovation and invention. The distribution of total sample respondents in terms of literacy level has shown that, 56.67% were illiterate at least they cannot read and write, 24.17% informally literate, they could read and write, 12.08% had attended formal education from grade 1 to 6, 5% were exposed to formal education from grade 7 to 8 and the remaining 2.08% have succeeded in reaching higher levels of grade 9 and above. The comparison by access to irrigation reveals that 40.63% of the users and 75% of the non-users are found to be illiterate, 28.13% of the user household heads and 19.64% of the non-users could read and write, 17.97% of the users and 5.36% non-users attended formal education from grade 1 to 6, 9.38% and 3.91% of the users of small-scale irrigation were exposed to formal education from grade 7 to 8 and higher levels of grade 9 and above respectively. The study indicated that farmers who had higher education level show eagerness to grasp new ideas and to try the technology by allocating some of the scarce resources. This could explain the variation with regard to participation decision of small-scale irrigation. Similarly, in this study the chi square test shows that there exists significant difference between users and non-users in relation to education level, at 1% level of significance.

Table 3: Socio-economic and institutional characteristics of the sample households (discrete variables)

Variables		Frequency	Percent
sexhead	Female(0)	48	20
	Male(1)	192	80
educ	Illiterate(0)	136	56.67
	Informally literate(1)	58	24.17
	Grade 1-6(2)	29	12.08
	Grade 7& 8 complete(3)	12	5.00
	Grade 9 and above(4)	5	2.08
acexten	No/ those who do not get Service(0)	113	47.08
	Yes/those who get Service(1)	127	52.92
soilfert	Infertile(0)	80	33.33
	Fertile(1)	160	66.67
accredit	No/those who do not take credit(0)	102	42.50
	Yes/those who take Credit(1)	138	57.50
acinfo	No/those who do not get information(0)	119	49.58
	Yes/those who get information(1)	121	50.42

Source: Computed from own survey data, (2013)

Age of the household head of sample respondents ranged from 24 to 78 years with mean of 47.39 years. The average ages of users and non-users was found to be 48.53 and 46.08 years respectively. The mean age difference between the two groups, however, is found to be statistically insignificant suggesting age has very little influence on the participation decision.

The man equivalent (ME) of the economically active family labor (15-64 years) was calculated for the sample respondents based on Bekele (2001) (See Annex). The average number of economically active family labor force for users and non-users were 6.48 and 5.27adult equivalent, respectively and that of the total sample was 5.92. The size of labour force in the household is expected a priori to contribute for variation on participation decision in small-scale irrigation and level of income. The main source of labour for crop production either in the irrigated or rainfed agriculture in the study area is family labour. The mean difference between the users and non-users was found to be statistically significant at 1% level of significance suggesting labor availability is an important factor influencing households' decision to participate in small-scale irrigation. The result also revealed, as active family labor or work force of a household in adult equivalent increases, the total income of the household increases, which in turn contributed to improved well-being, further providing an evidence for the importance of labor availability in influencing the participation decision of households in small-scale irrigation. Labor shortage was reported to be one of the problems faced by the sample respondents for weeding, harvesting, threshing, watering, livestock herding and ploughing. Findings from the study demonstrated from the total sample respondents, 52.5% reported that they faced labor shortage. The breakdown of this information reveals that about 60.94% of the users and 42.86% of non-users of small-scale irrigation have faced labor shortage. In the study area rural farm households who faced labor shortage employ different mechanisms to acquire additional labor required for accomplishing farm activities. A total of 40.63% and 20.31% of the irrigation users, who faced labor shortage, acquired additional labor through hiring and labor exchange mechanisms, respectively. Most of the casual labor employed in irrigation farming was source from the non-users of irrigation within the kebele or woreda whereas some of the casual labors were from nearby kebele/woredas that are very low in irrigation sources. This proves irrigation utilization intensifies labor and is preeminent strategy to supports the livelihood of the non-users through employment opportunities.

The average land holding of the surveyed households equals to 1.58 hectare with a minimum of 0.5 to a maximum of 3.5 ha. This figure is larger than the average national figure, which is 1.2ha (CSA, 2008) indicating the existence of relatively higher land holdings in the study area. The mean land holding for users is 1.74 ha and the corresponding figure for the non- users households is 1.4 ha. The t-test revealed that the mean difference between the two groups is statistically significant at 1% level of significance and it shows land holding difference determines small-scale irrigation participation and income level. In the study area the major means of land acquisition was through land redistribution, inheritance and, rented in land. Although the Ethiopian government policy does not allow the sale of land, as it is considered a public property. However, the renting out of land through certain agreeable arrangements between individuals is a common practice in all study areas. This is mainly done through contractual arrangements to share the harvest and tends to occur when the owner of the land cannot cultivate by himself/herself. The land is leased for a temporary period (e.g. one season or one year or 2-3 years) to the cultivator on the basis of different crop sharing agreements. The rate of share depends on the quality of the land, access to irrigation and distance of the farm plot from the village however; a 50 to 50 percent ratio was the most common crop sharing arrangement. The survey result revealed that about 66.41% of users and 46.43% of non-users renting in land during the survey year. This shows that irrigation users are better off practicing land renting in than non-users are. On the other hand, 12.5% of the users and 25.89% of the non-users have rented out their plots of land for different reasons. The major reason for renting-out land was reported to be lack of oxen, seed shortage, labor shortage and disability. In the study area most of the female headed households renting out their farm plot to the male headed households. Whereas, possible reasons for renting-in land, 24.58% of the respondents reported shortage of land, 16.25% having extra seed, labour and shortage of land, 8.33% having extra labour and shortage of land, 5.42% having extra seed and shortage of land and the remaining 2.5% having extra labour.

Table 4: Distribution of sample respondents by reasons they have provided for renting in land

Reason for renting-in land	Non-users		Users		Total sample	
	N	%	N	%	N	%
Shortage of land	23	20.54	36	28.13	59	24.58
Possess extra seed, labor and face shortage of land	16	14.29	23	17.97	39	16.25
Possess extra labor and face shortage of land	6	5.36	14	10.94	20	8.33
Possess extra seed and face shortage of land	3	2.68	10	7.81	13	5.42
Possess extra labor	4	3.57	2	1.56	6	2.5

Source: Computed from own survey data, (2013)

Out of the total irrigation user sample households (128), 17.97% of the respondents faced a problem of crop failure while using irrigation. Out of these 11.72% of respondents revealed the reason of their crop failure was due to crop disease while 6.25% of the respondents reason of crop failure was water shortage. Rainfed crops were cultivated by both irrigating and non-irrigating households. But, unlike irrigating households, non-irrigating households depend only on rainfed cultivation. The findings of the study also revealed the major reasons for non-irrigating households why they didn't participate in irrigation. The non-users of small-scale irrigation have different reasons for rejecting irrigation utilization. From the total irrigation non-user households, 38.39% of the respondents didn't participate because they don't have farmland in surface water access, 33.93% of respondents due to limited information about irrigation and lack of financial capital. On the other hand, 27.68% of them is due to their expectation that the rain-fed land they owned is too fertile and can produce better.

Table 5: Socio-economic and institutional characteristics of the sample households (continuous variables)

Variables	Observations	Mean	St.dev.	Min.	Max.
age	240	47.39	11.74	24	78
dismkt	240	6.56	2.5	2	14
livestock	240	6.21	2.67	1	13.48
totinc	240	42136.65	15957.39	16945	65349
dishom	240	3.69	1.55	0.5	7
famlabor	240	5.92	2.35	1	11.51
cultland	240	1.58	0.913	0.5	3.5

Source: Computed from own survey data, (2013)

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. The types of livestock found in the study area were cattle, equine, sheep, goat and chicken. To help the standardization of the analysis, the livestock number was converted to tropical livestock unit (TLU). Conversion factors used were based on Desale (2008) and indicated in annex. 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 draught power used for different farming activities is taken as major source of production in the study area. The farmer with higher number of oxen was more confident to participate in small-scale irrigation than his/her counterparts because he/she has one of the most important factors of production which enables the farmers to finish farming activities efficiently on time. The average livestock holding of respondents was 6.21 TLU, where the minimum is 1 and the maximum is 13.48. The mean livestock holding of users was 7.18 while that of the non-users was 5.1TLU. This study indicated that there was a significant difference in livestock holding between users and non-users at a 1% significance level. This shows that users have higher livestock holding than the non-users. It could also indicate that users have better access to financial source through sell of livestock which could be used to purchase farm inputs, such as high yielding variety seed and fertilizer, and livestock used for minimizing risk.

Livelihood of households within the farming community was found to depend on diverse portfolio of activities and income sources. Farmers in the study area reported that they earn income both from farm and off farm activities. The farm income includes the sale of rain fed crops, irrigated crops and sales of livestock and its products. The off farm activities include working as a guard, grain and livestock trading, sale of Tela (local beer), sale of firewood and charcoal, stone mining, petty trading, weaving, mat making, pottery and handcraft and income earned from households' labor supplied outside their own farm plot etc. Here off farm activities comprises any farm activities takes place outside own plot or farm and any non-farm activities. The mean annual income of sample households is found to be Birr 42136.65 with a minimum of Birr 16945 and a maximum income of Birr 65349. There is much difference in mean annual income between irrigation users and non users. Households with access to irrigation have mean annual income of Birr 56166.59 and the average for the non-users is Birr 26102.44. The t test analysis revealed that the difference of mean annual total income of the users and non-users are statistically different from each other at 1% level of significance. Household income or consumption expenditure data has been used as one means to compare the welfare level among households. However, in developing countries consumption is typically preferred over income as the former better captures the welfare level of a household. In the country as a whole and particularly in the study area asking questions pertinent to yield of crops, and income earned is sensitive. Farmers were reluctant to respond truly when requested to comment on yield and income aspects. They usually underestimate the yield and income earned because of the fear that higher taxes might be levied on them due to high yield and income, possibility of exclusion from aid the government agencies and/or NGOs supply in the area was also another concern. Hence, yield and income data obtained by interviewing farmers are subject to underestimation. Therefore to overcome this biasness the study used expenditure approach to assess the effect of small-scale irrigation on income since the problem created by underestimation may not create bias in the analysis of effect of small-scale irrigation on income. The reason that we prefer expenditure approach instead of income approach is that; first expenditure is believed to vary more smoothly than income i.e. expenditure is considered as more stable compared to income, secondly expenditure is more readily observed, recalled and measured than income and thirdly people are more willing to tell expenditure than income.

Access to market is a determinant of profitability and sustainability of agricultural produce. 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. The survey result indicated that the average distance of respondents' farm from the nearest market place is found to be 6.55 km with a minimum of 2 km and a maximum of 14 km. The average for households with access to irrigation is 6.05 km while the corresponding figure for the non-user households is 7.14 km. The result shows that the user households have a better access to market. The mean difference between the two groups with regard to distance from the nearest market center is statistically significant at 1% level of significance. Households in the study area use different ways of transporting their agricultural produce to the market place. 36.72% of the users and 38.39% of the non-users use donkey, 29.69% of the users and 35.71% of the non-users carrying on human back, 26.56% of the users and 25.89% of the non-users use both carrying on human back and load on donkey and 7.03% of the users in group use hired vehicle to transport their agricultural produce to the market place. Almost all of the small-scale irrigation user households complain as they didn’t get reasonable price for the agricultural products produced by irrigation. According to their opinion the main reason for the low price of the agricultural products produced by irrigation was the nature of the product. The commodities produced by small-scale irrigation have perishable nature that is why as soon as harvested the entire farmer supplies such products to the market simultaneously since it can’t be stored. As a result the supply of such products exceeds the demand in the market and it makes the price go down.

Table 6: Summary of descriptive statistics for continuous variables by access to irrigation

Variables	Non-users (N=112)		Users (N=128)		Total sample (N=240)		T-value for mean difference
	Mean	st.dev.	Mean	st.dev	Mean	st.dev.	
age	46.08	11.34	48.53	12.00	47.39	11.74	1.6194
famlabor	5.27	2.24	6.48	2.30	5.92	2.35	4.1225***
dismkt	7.14	2.43	6.05	2.46	6.56	2.50	-3.4630***
livestock	5.1	2.33	7.18	2.57	6.21	2.67	6.5433***
totinc	26102.44	2918.4	56166.59	6829.15	42136.65	15957.39	43.2534***
cultland	1.4	0.77	1.74	1.00	1.58	0.913	2.8934***
dishom	4.07	1.49	3.36	1.53	3.69	1.55	-3.6354***

Source: Computed from own survey data, (2013)

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

In the study area soil infertility is not a major problem. Majority of the respondents said that they do not have soil fertility problem, only 33.33% percent of them reported that their land is not fertile. The comparison between user and non-user households showed that 73.44% of the users and 58.93% of the non- users have fertile land (according to their opinion). The chi square test revealed that there is a statistically significant relationship between soil fertility status and access to irrigation at 5% level of significance.

Comparing small-scale irrigation users versus non-users in terms of distance from the water source, the mean difference between the user and non-user is statistically significant at 1% level of significance. The mean distance of the sample household from the water source is 3.69km with minimum of 0.5km and maximum of 7km. The mean distance of the user households from the water source is 3.36km while the corresponding figure for the non-user is 4.07km indicates that the user households have better irrigation access.

Credit either in the form of cash or kind from different sources, is an important institutional service to finance poor farmers for input purchase and ultimately to adopt new technology. However, some farmers have access and utilization to credit while others may not have due to problems related to repayment and down payment in order to get input from formal sources. The main source of credit in the study area is micro finance institute (Amhara Credit and Saving Institution (ACSI)) but service cooperatives, associations such as women's associations also provide credit services to their members. Moreover, non formal sources were also providing micro credit services to the community. These included: relatives, friends, local moneylenders, local community insurance (Iddir) or rotating savings and credit associations (Equb). The survey indicated 57.5% of the sample households utilized credit while 42.5% of the sample households do not take credit due to various reasons. The comparison by access to irrigation disclosed that 79.69% of the users and 32.14% of the non-users had utilized credit although the access is equal to all households without any difference, While 20.31% of the users and 67.86% of the non-users did not take credit. This implies that users had better access to credit compared to non-users. The chi square test result revealed that the relationship between access to credit and access to irrigation is statistically significant at 1% level of significance. Respondents reported about problems revolving around credit were related to many factors. 8.33% of the respondents refrained from credit because of high interest rate, 12.5% because of shortage of money for down payment, 7.5% because of shortage of money for repayment, 5.42% because of its unavailability on time and 8.75% of the sample households said that they don't want credit.

Table 7: Distribution of sample households by types of constraints faced in the use of Credit

Problems related to credit use	Non-users (N =112)		Users (N =128)		Total sample (N =240)	
	N	%	N	%	N	%
High interest rate	18	16.07	2	1.56	20	8.33
Shortage of money for down payment	22	19.64	8	6.28	30	12.5
Not available on time	10	8.93	3	2.34	13	5.42
Shortage of money for repayment	14	12.5	4	3.13	18	7.5
Don't want credit	12	10.71	9	7.03	21	8.75

Source: Computed from own survey data, (2013)

By kebeles, there is variation in small-scale irrigation participation. Overall, there exists higher small-scale irrigation participation in Sufankara, Guramba Michael and Tana woina. This may be due to two reasons: the first reason is the proximity to the main source of water.The main source of water for irrigation for these kebeles is Megech River and the river crosses these kebeles. The second reason is that proximity to the nearest market place. Koladba which is the capital of the woreda is the nearest market place for all sample kebeles but, compared to the other it is very near to these kebeles. In the study area, farmers intensively produce horticultural crops such as; onion, garlic, tomato, pepper, potato, lettuce, cabbage, carrot and other spices, fruits and tubers. Some households also produce maiz and wheat by using small-scale irrigation in the study area but, Vegetables were the more commonly produced crops with small-scale irrigation systems. Of all vegetable production in terms of the number of growers by irrigating households, onion takes the lions share the greatest proportion; which was predominant in all study areas. According to their opinion onion is better than other vegetables in terms of amount of yields produced and demand in the market, the seeds for onions are easily obtained from the wereda market, Onions are less perishable and easy to harvest and transport when compared to other crops, In comparison to other vegetables onion have a relatively long shelf-life, but it requires frequent watering. However, farmers realized that concentrating on a single crop (onion) has had a negative implication in that it causes competition for markets among producers. This is particularly difficult when they supply their product to the market at a similar time leading to a fall in market prices due to an oversupply of onions in the market place Crops grown using small-scale irrigation were few in number, but there are different reasons why they are grown by irrigating households. The major factors for production decision were good production (42.19 %), better price (25%) and easier to cultivate (14.84%). There are other reasons such as disease resistant, seed availability; water scarcity and others accounted 17.97 % of the respondents. The following table summarizes small-scale irrigation participation of sampled respondents by kebeles.

Table 8: Small-scale irrigation participation by kebeles

Name of kebeles	Irrigation non-users		Irrigation users	
	N	%	N	%
Sufankara	17	7.08	31	12.92
Guramba Michael	20	8.33	28	11.67
Tana Woina	23	9.58	25	10.42
Ateklt Teleft	27	11.25	21	8.75
Abredgeha	25	10.42	23	9.58

Source: Computed from own survey data, (2013)

With regard to access to information it was assumed that respondents who owned radio and/or mobile got information regarding new technologies. Information on market prices and channels is one of the important aspects for livelihood improvement of rural farm households. In focus group discussion with participants it was noted that there were lack of market information directly affected farmers from obtaining a reasonable and better price for their produce. Their main sources of market information on the study area were traders. Due to lack of market information many farmers produce similar crops in similar seasons leading to a flooding of the markets with the same type of agricultural produce which in turn forced them to sell their produce at lower prices. In addition to this, market information is crucial to 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 household's income in the study areas. Although information on marketing of irrigation products and agricultural inputs is a determinant factor for producers, only 50.42% of the sample households secure information and 49.58% didn't get information. The comparison by access to irrigation disclosed that 68.75% of the users and 29.46% of the non-users have access to information, while 31.25% of the users and 70.54% of the non-users did not get information. The percentage difference on access to information was statistically tested and it was found to be significant at 1% level of significance. This revealed that there was systematic association between access to information and small-scale irrigation participation. It shows that higher access to information could increase participation in small-scale irrigation.

Table 9: Summary of descriptive statistics for discrete variables by access to irrigation

variables	values	Non-users (N=112)	Users (N=128)	Total sample (N=240)	χ^2-value (p-value)
sexhead	0	43(38.39)	5(3.91)	48(20)	0.000***
	1	69(61.61)	123(96.09)	192(80)	
educ	0	84(75)	52(40.63)	136(56.67)	0.000***
	1	22(19.64)	36(28.13)	58(24.17)	
	2	6(5.36)	23(17.97)	29(12.08)	
	3	0	12(9.38)	12(5.00)	
	4	0	5(3.91)	5(2.08)	
acinfo	0	79(70.54)	40(31.25)	119(49.58)	0.000***
	1	33(29.46)	88(68.75)	121(50.42)	
soilfert	0	46(41.07)	34(26.56)	80(33.33)	0.017**
	1	66(58.93)	94(73.44)	160(66.67)	
accredit	0	76(67.86)	26(20.31)	102(42.50)	0.000***
	1	36(32.14)	102(79.69)	138(57.50)	
acexten	0	95(84.82)	18(14.06)	113(47.08)	0.000***
	1	17(15.18)	110(85.94)	127(52.92)	

Source: Computed from own survey data, (2013)

Note: ***and** represent statistically significant at the 1% and 5%, significance level, respectively and numbers in parentheses indicate percentages.

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 survey result revealed that 52.92% of the sample households get extension service. When we compare irrigation user and non user households' majority of the user households get support from extension agents when compared to non irrigators. According to the survey 85.94% of the users and 15.18% of the non-users get extension service. Extension service here refers to advice, training, demonstration related to crop and horticultural production. The chi square test indicated that there is significant relationship between access to irrigation and access to extension service at 1% level of significance. With regard to the frequency of extension contact from among the total respondents 6.67% contact five times and above per month, 9.58% four times per month, 17.5% three times per month, 12.08% two times per month, 7.08% once in month and the remaining 47.08% have no contact with extension agents.

Table 10: Distribution of sample households' frequency of contact with extension agents

Frequency of extension contact	Non-users (N=112)		Users (N=128)		Total sample (N=240)	
	N	%	N	%	N	%
No contact	95	84.82	18	14.06	113	47.08
Once in a month	3	2.68	14	10.94	17	7.08
Twice per month	5	4.46	24	18.75	29	12.08
Three times per month	4	3.57	38	29.69	42	17.5
Four times per month	2	1.79	21	16.41	23	9.58
Five times & above per month	3	2.68	13	10.16	16	6.67

Source: Computed from own survey data, (2013)

4.2 Results of the Econometric Model

In this particular study, to identify and analyze farm level determinants of small-scale irrigation participation and its effect on income, the heckman two stage model has been used and analyzed. For the first stage of the heckman's two stage model i.e. the small-scale irrigation participation, probit model were used with thirteen demographic and socio economic variables such as age and agesquare of the household head in years, distance from the nearest market center in kilometer, amount of land holding in hectare, availability of family labor force in number, distance from home to the water source in kilometer, education level of the household head, total livestock owned in TLU, access to credit, gender of the household head, access to information, access to extension service and perception of soil fertility status are entered and analyzed with the help of Stata. For the second stage of the model i.e. outcome equation again thirteen demographic and socio economic variables such age and agesquare of the household head in years, distance from the nearest market center in kilometer, amount of land holding in hectare, availability of family labor force in number, education level of the head, livestock owned in TLU, access to credit, gender of the household head, access to information, access to extension service, perception of soil fertility status and inverse mills ratio(lambda) are used.

4.2.1 Estimation Procedures

Prior to the estimation of the parameters of the model, the data have been tested for multicollinearity, hetroskedasticity and normality problems using different STATA commands. 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 (creates very large standard errors), sign of the estimated regression coefficients may be opposite of hypothesized direction, smaller t-ratios that might lead to wrong conclusions (Wooldridge, 2003). Thus, the existence of serious problem of multicollinearity among the variables is examined by the help of Variance inflation factor (VIF) for the continuous variables and the values of contingency coefficient (CC) for the discrete variables. For the continuous variables the VIF greater than ten reveals strong correlation and measures inflation in variance in due to multicollinearity and the value of contingency coefficient is a chi-square based measure of association where a value of 0.75 and above shows the existence of strong multicollinearity problem. 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. Therefore, these continuous explanatory variables were included in the model. Similarly, the contingency coefficient (CC) results showed absence of strong association between different hypothesized discrete explanatory variables, since the respective coefficients were very low (less than 0.75) as given on annex. Therefore, the dummy variables were included in the model. For this reason, all of the explanatory variables were included in the final analysis. In Heckman's selection model normality and homoskedasticity of the error term should hold (Green, 2003). Hence, these assumptions required to be tested. We tested hetroskedasticity for outcome equation and normality of the error terms for the different regression outcomes. We used Breusch-Pagan hetroskedasticity test to check existence of hetroskedasticity problem for errors. To check for normality of data, in Stata, we can test normality by either graphical or numerical methods. Through graphical method we have checked the data by drawing histogram and through numerical methods we have used skewness and kurtosis as well as the Shapiro-Wilk and Shapiro-Francia tests are used (Park, 2008). Be aware that in all these numerical tests, the null hypothesis states that the variable is normally distributed. The homoskedasticity for the outcome equation and normality assumption for both the participation and outcome equation of the models are not rejected. For probit 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.

4.2.2 Results of Probit Model for the Determinants of Small-Scale Irrigation Participation Decision of the Sample Households

As already mentioned in the methodology section, this study employs the Heckman two stage model to estimate and infer the parameters of the determinants of smallholder rural farm households' small-scale irrigation participation decision and its effect on income in the study area. The results of the maximum likelihood estimation of the first stage of the heckman model showed that all demographic and socio-economic factors, except age and agesquare of the household head, perception of soil fertility status and cultivable land, have significant effect on the probability of smallholder rural farm households' small-scale irrigation participation decision.

Out of the total thirteen explanatory variables, output for the probit /participation equation shows that nine variables of which four are continuous and five are dummies, were found to be significantly creating variation on the probability of rural farm households' small-scale irrigation participation or determine the probability of using irrigation. Variables found to be significant included; distance from households farm to the nearest market center(dismkt), education level of the household head(educ), distance from households residence to the water source (dishom),access to extension service(acexten),total livestock holding in tropical livestock unit(livestock), access to information(acinfo),availability of family labor force(famlabor),access to credit(accredit) and gender of the household head(sexhead). In general, the sign of coefficients of all variables have been as prior expectation except for age and agesquare. The coefficients of age and agesquare of the household head, perception of soil fertility status and cultivable land were not statistically significant at all 1%, 5% and 10% significance levels implying that they were less important in affecting the probability of participation in small-scale irrigation. Size of cultivable land has insignificant impact on the probability of participation in small-scale irrigation. The possible explanation is that in the study area households are engaged in a very small-scale irrigation because of water and other input constraints. Therefore, whether the household owns large size or small size of cultivable land, it doesn't matter for the households' participation decision in small-scale irrigation.

With the above brief background, the effect of the significant explanatory variables on smallholder rural farm households' decision to participate in small-scale irrigation is discussed below.

Distance of the households' farm from the nearest market (dismkt): The results of the model showed that distance of farmers' farm from the nearest market center is associated with the probability of the participation of farmers in small-scale irrigation 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 chance for participation in small-scale irrigation. 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 small-scale irrigation. If the farmers’ farm was not near to the market that might increase costs of marketing the products. The farther the market center is the lesser the income from the sell of farm produce. Especially for perishable commodities if the market place is located far away from the farm, the commodity may perish before arriving the market and to avoid such incidences the farmer sells his output for cheaper price reducing the income as a result, since farmers do not get reasonable price for their output, they become discouraged and stop from participation in small-scale irrigation. The marginal effect of this variable reveals that, keeping all other variables constant at their mean value, as the distance from farmers farm to the nearest market increases from 6.56 to 7.56 kilometer, the probability of participation in small-scale irrigation reduces by 6.36 percentage points. Similar results were reported by Kidane (2001) and Haji (2003). This implies that distance to the nearest market in different localities had similar influence on the adoption of technology or participation decision.

Distance of households’ residence from the water source (dishom): This variable was found to influence small-scale irrigation participation negatively and significantly at 1% significance level. The implication of this negative relationship was that the farther households' residence from the water source, the lesser would be farmers’ initiative to participate in small-scale irrigation. The possible justification could be households who are farther to the irrigation scheme incur much cost to access their farm so they can’t follow up the farm activity closely and frequently and may not get a better yield; therefore, they delay in deciding to participate in small-scale irrigation. Conversely, the nearer a household resides to a water source, the higher the probability of participating in irrigation scheme due to the fact that the opportunity cost of the time lost in travelling to and from an irrigation-farm for households located a short distance from irrigation schemes would be much lower than households located much farther. Besides, the lower transaction cost households located near water sources enjoy, and also are likely to have a better awareness of the associated agricultural technologies due to their proximity. The marginal effect of this variable shows that as the distance from the farmers’ residence to the water source decreases from 3.69 to 2.69 kilometer, the probability of participation in small-scale irrigation increases by 9.90 percentage points, while other variables are kept constant at their mean value.

Total livestock holding (livestock): Consistent with a priori expectation livestock holding, measured in tropical livestock unit, was found to have positive and significant effect at 1% level of significance on the probability to participation in small-scale irrigation which confirms the hypothesis. The positive relationship indicates that households with larger livestock holding may have money to spend on any possible cost to participate in the irrigation activity. Moreover the implication of the result was that livestock are an important source of cash in rural areas to allow purchase of farm inputs that are needed to participate in small-scale irrigation. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with the participation in small-scale irrigation. In addition to the provision of the traction power, the livestock they maintain serve as a source of additional income and food. Given this potential contribution of livestock to sustainable household food supply; they encourage adoption of small-scale irrigation. Evidence from the study area reflects that farmers who have larger number of livestock are wealthier and have sufficient number of oxen to plough their field timely as a result of which they quickly decide to participate in the small-scale irrigation. Livestock may also serve as a proxy for oxen ownership, which is important for farm operations. The marginal effect shows that as the number of livestock in tropical livestock unit increases from 6.21 to 7.21, the chance to participate in small-scale irrigation increases by 5.8 percentage points, while keeping all covariates constant at their mean value. The same results were reported by Tesfaye el al (2001), Haji (2003) and Desale (2008). This implies that livestock holding has an influence on the participation decision in new technology in different areas.

Availability of family labor force (famlabor): This variable was found to influence households' decision to participate in small-scale irrigation positively and significantly at 5% level of significance. The positive association implies that like other parts of Ethiopia, labor is one of the most extensively used inputs of agricultural production in the study area. Participation in small-scale irrigation demands additional labour force for different farming operations. Family size in adult equivalents indicates the sample households' average family labor force for agricultural production and other income-generating activities. Large household family size in adult equivalent means a larger amount of labor available to the household. Labor increases productivity per ha of land, and in turn, household total income increases for a given land base. A household with large labor force can participate in small-scale irrigation more than a household with small number of labour force. The marginal effect of this variable reveals that as the family labor force increases from 5.92 to 6.92, the probability of the households' participation in small-scale irrigation increases by 5.27 percentage points, while keeping all other variables constant at their mean value.

Level of Education of the household head (educ): Economic growth is driven by change in people's capabilities or their human capital, as affected particularly by their education. Educated people can more easily contribute to the generation of new technologies and more readily utilize those technologies. Moreover educated peoples manage their fields properly and then this 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 participation in small-scale irrigation and highly significant at 1% level of significance. This is 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 for decision making. Educational attainment by the household head could lead to awareness of the 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, educated household heads have 18.84 percentage points more chance of participation in small-scale irrigation than those illiterate household heads.

Access to extension services (acexten): 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). Moreover farmers that have frequent contact with DAs get information on new technologies more frequently and easily. This might increase their agricultural production and productivity. Therefore, access to extension service influences the farm households' participation in small-scale irrigation positively. Phoebe et al. (2000), found that exposure of the farmers to extension services and their access to up to date farm information increased the probability to adopt new technology. The study result also reveals that access to extension services is statistically significant at 1% level of significance and the marginal effect reveals that those households who have access to extension service have 60.25 percentage points more chance of participation in small-scale irrigation than their counter parts, 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 participation in small-scale irrigation by 60.25 percentage points higher than their counterparts, holding other variables constant at their mean value.

Gender of the household head (sexhead): Male headed household is more likely to adopt modern irrigation system than female headed household. Because females of the study area as females of elsewhere have triple burden (production, reproductive and childcare), and also they have less access to information about the technology due to the above mentioned burden than male headed household, then due to the case of sex difference of household head has influence in the participation in small-scale irrigation. Moreover, with regard to farming experience males are better than the female farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the small scale irrigation as early as possible than their counterpart. The study result also reveals that gender of 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 46.41 percentage points more chance of participation in small-scale irrigation than female headed households or the discrete effect of a change from 0 to 1 in gender of the household head increases the probability of participation in small-scale irrigation by 46.41 percentage points while keeping all other variables constant at their mean value.

Access to information (acinfo): Information on markets is a determinant factor for irrigation technology adoption. Consequently, access to market information is found to influence participation in small-scale irrigation, significantly and positively. Information on market prices and channels is one of the important aspects for livelihood improvement of rural farm households. In addition to this, market information is crucial to 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 areas. 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 33.72 percentage points more chance of participation in small-scale irrigation than those households who do not have access to 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 33.72 percentage points while keeping all other variables constant at their mean value.

Access to credit (accredit): this variable positively influences irrigation participation decision of households. It is statistically significant at 1% significance level. The positive relationship could be because those households who have access to credit have a better possibility of getting farm inputs. Credit helps farmers purchase inputs such as seeds, fertilizers. Therefore the probability of participation in small-scale irrigation increases. The marginal effect of this variable revealed that those households who have access to credit have 35.46 percentage points more chance of participation in small-scale irrigation than those households who do not have access to credit, while keeping the all other variables constant at their mean value or the discrete effect of a change from 0 to 1 in access to credit of the household increases the probability of participation in small-scale irrigation by 35.46 percentage points while keeping all other variables constant at their mean value.

Table 11: Maximum likelihood estimates of the binary probit model and its marginal effect on the determinants of small-scale irrigation participation

Explanatory variables	Coefficient	Z	P>|Z|	Marginal effect (+)
dismkt	-0.1645865	-2.66	0.008	-0.0636426***
educ	0.487234	2.84	0.005	0.1884044***
dishom	-0.2561372	-2.74	0.006	-0.0990435***
acinfo	0.8989766	3.25	0.001	0.3372398***
livestock	0.1507195	2.99	0.003	0.0582805***
soilfert	0.1029363	0.41	0.683	0.039952
cultland	0.1690745	1.23	0.220	0.065378
sexhead	1.247815	2.43	0.015	0.4641474**
famlabor	0.1364162	2.13	0.033	0.0527496**
age	-0.0901137	-1.12	0.261	-0.0348453
accredit	0.9352274	3.45	0.001	0.3545781***
acexten	1.726107	5.90	0.000	0.6025183***
agesquare	0.0009357	1.17	0.243	0.0003618
cons	-1.014941	-0.43	0.667	

Dependent variable	Irrigation Participation Decision
Number of observations	240
Log pseudo likelihood	-53.198789
Wald chi2 (13)	108.78
Prob > chi2	0.0000

Source: Computed from own survey data, (2013)

Note: *** and ** indicate significant at the 1% and 5% level, respectively

(+) For dummy variables the marginal effect is the discrete change of dummy variables from 0 to 1, P>|z| correspond to the test of the underlying coefficient being 0.For definitions of variables, (See Table 2).

4.2.3 Heckman two stage Model Estimates for the Effect of Small-Scale Irrigation on Income

This study was based on the farmers interview and this section attempts to address the effect of small-scale irrigation on households' total annual income in Dembia woreda. This can help in particular to understand why some households are better able to derive income from small-scale irrigation than others. Since many households do not derive income from small-scale irrigation as a result their income is not observed for the non-participants. 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 income equations, because Heckman model helps as to consider observations that have missed data. Heckman model has also been used by other authors in similar contexts (Hagos & Holden, 2003; Brick et al., 2005).The covariates that we use to analyze the participation in small-scale irrigation are also used to identify the factors that affect income from them. To avoid identification problem that could arise during estimation, the variable distance from the households' residence to the water source has been excluded from the income equation (outcome equation) and used only in the corresponding selection equation. The correlation of this variable with other variables in the income equation is tested and the test result revealed that this variable doesn't have correlation with any one variable in the income equation. The results for the outcome equations of the Heckman two-step selection models are presented in Table 12. Here, results for the outcome equations are estimation results for determinants of income after correcting for selection bias. According to 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's two-stage procedure. The negative sign suggests that the error terms in the participation and outcome equations are negatively correlated. This shows that those unobserved factors that make the household participate in small-scale irrigation are likely to be negatively associated with household income level also.

As the first stage represents participation, which has discussed above, here we focus on the second stage, which describes the effect of small-scale irrigation on household income given households participation. Out of the total thirteen explanatory variables, output for the income /outcome equation of the model, seven variables are found to be significant determinants of household income. These are access to irrigation(acirrig), access to credit(accredit),gender of the household head(sexhead),size of cultivated land(cultland),access to extension service(acexten), total livestock holding(livestock) and the inverse Mills ratio (lambda).But In general, 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 farm households' income level is discussed below.

Access to irrigation (acirrig): Irrigation, as one of the technology options available, enables the farmers to diversify their production, practice multiple cropping and supplement moisture deficiency in agriculture. In doing so, it helps the farmer to increase production and income. Therefore, access to 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 twice or more in a year as, a result increased and stable production income and consumption. The coefficient of this variable revealed that, keeping all other variables constant, on average the total annual income of irrigation user households would be higher by Birr 29154.16 than households who do not participate in irrigation farming. Participation in small-scale irrigation, therefore, enables farm households to improve their well-being by not only allowing higher income but also minimizing risk and smoothening household consumption.

Total livestock holding (livestock): 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. Livestock holding in tropical livestock unit contributes to total household income directly through the sale of livestock and their products, and indirectly through use as a source of draught power for crop production activities. Moreover Livestock, besides its direct role in raising agricultural productivity, helps households stabilize consumption by absorbing income shocks that might arise from crop failures triggered by natural disasters. Oxen are the sole draught power sources and hence lack of oxen besides its negative effect on land productivity signifies a lower economic status of farm households. Households with 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 TLU increase in livestock holding would increase on average the total income of a household by Birr 1112.97, while keeping all other variables constant at their mean value.

Access to credit facility (accredit): 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. 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. According to the results of the study, keeping all other variables constant, on average the income of households who have access to and utilized credit would be higher by Birr 6634.95 compared to households who do not have access to credit.

Gender of the household head (sexhead): Male household heads have higher income compared to female household heads because of better labor inputs used in male-headed households than the female headed ones. In addition females of the study area as females of elsewhere have triple burden (production, reproductive and childcare), and also they have less access to information about the technology then due to the case of sex difference of household head has influence in the level of income of households. Moreover, with regard to farming experience males are better than the female farmers since it is assumed that male household heads have more exposure and access to information and new interventions than female household heads, which might enable them to participate in the small-scale irrigation as early as possible and their income is higher than their counterpart. The study result revealed that this variable is statistically significant at 1% significance level and the coefficient of this variable also shows keeping all other variables constant, on average income of those male headed households exceeded by birr 6835.59 compared to those households headed by female.

Size of cultivated land (cultland): Land is key asset of rural farm households and this asset is a prerequisite in the productive activities for agricultural production. The study revealed that land is positively associated with household total income as expected and is statistically significant at 10% level of significance. The result discloses that, as the cultivated land size increases, the household is able to increase and diversify the quantity and type of crop produced on the cultivated land this may in turn imply increased income of the household. Generally land is important fixed input to increase production and income. The coefficient of the variable also shows that as the household gets one more hectare of land on average the total annual income of the households' increases by Birr 1274.74 keeping all other variables constant at their mean value.

Access to extension service (acexten): This variable is statistically significant at 5% level of significance and has the expected positive sign. The positive relationship may indicate that in the study area, those households who get technical advice, training or those who participated on field demonstrations are well aware of the advantage of agricultural technologies and willing to adopt new technologies and produce more, thereby improving the household level of income. The coefficient of the variable indicates keeping all other variables constant, on average the income of households who have access to extension service would be higher by Birr 4371.16 compared to households who do not have access to extension service.

Table 12: Heckman two stage estimates for the outcome equation

Explanatory Variables	Coefficient	P-value
cons	28003.41	0.000***
livestock	1112.968	0.000***
dismkt	-60.332	0.768
cultland	1274.743	0.061*
educ	296.441	0.429
acinfo	1032.005	0.405
acirrig	29154.16	0.000***
soilfert	265.699	0.799
sexhead	6835.594	0.010***
famlabor	192.460	0.361
age	284.549	0.264
accredit	6634.947	0.000***
agesquare	-2.841	0.272
acexten	4371.16	0.016**
lambda	-3028.899	0.035**
Dependent variable	household total annual income	
Number of observations	240	
Censored observations	112	
Uncensored observations	128	
Wald chi2 (24)	103.66	
Prob > chi2	0.0000	

Source: Computed from own survey data, (2013)
Note: ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively

The study also runs the Ordinary Least Square (OLS) model to compare the result of the estimate with the Heckman two stage analyses. As expected the model result identified that access to irrigation is a significant determinant of household total annual income. But the size of the coefficient for the Heckit model is higher than that of the OLS regression result. Thus, using OLS regression model underestimates the effect of small-scale irrigation on household total annual income level.

Table 13: Ordinary Least Square estimation of model variables

Explanatory Variables	Coefficient	P-value
cons	17179.77	0.000***
livestock	615.673	0.085*
dismkt	-89.741	0.502
cultland	675.495	0.063*
educ	474.198	0.192
acinfo	-426.758	0.550
acirrig	24735.91	0.000***
soilfert	-700.924	0.315
sexhead	2327.517	0.011**
accredit	3795.75	0.000***
famlabor	-31.850	0.825
age	209.101	0.257
acexten	2453.094	0.009***
agesquare	-2.212	0.238
Dependent Variable	household total annual income	
Number of observation	240	
F(13,226)	177.63	
Prob > F	0.0000	
R-squared	0.9109	
Adj R-squared	0.9057	

Source: Computed from own survey data, (2013)

Note: ***, **, and * indicate statistically significant at the 1%, 5%, and 10% level, respectively

4.2.4 Relative Importance of Significant Variables Influencing Small-Scale Irrigation Participation and Income

It is presumed that not all the statistically significant qualitative and quantitative explanatory variables of the model have the same level of importance on households' participation decision in small-scale irrigation and level of income. The relative importance of the qualitative and quantitative explanatory variables for the households' participation decision in small-scale irrigation can be seen by comparing the variables level of significance and the coefficients (the probabilities) that would result from changes in values of these variables. Accordingly; access to extension service, total livestock holding, distance from households' farm to the nearest market, access to information, level of education of the household head, access to credit facility and distance from households' home to the water source are statistically significant variables influencing decision to participate in small-scale irrigation at 1% level of significance and availability of family labor force and gender of the household head are also statistically significant variables influencing decision to participate in small-scale irrigation at 5% level of significance. In the study area the relative importance of significant variables influencing small-scale irrigation participation in descending order are; access to extension service by 60.25percentage points, access to credit facility by 35.46percentage points, access to information by 33.72percentage points, level of education of the household head by 18.84percentage points, distance from households' residence to the water source by 9.9percentage points, distance from the households' farm to the nearest market place by 6.36percentage points, total livestock holding by 5.83percentage points, gender of the household head by 46.41percentage points and availability of family labor force by 5.27percentage points.

Similarly, the relative importance of those statistically significant quantitative explanatory variables influencing the outcome equation (households' total annual income) can be seen by comparing the total variation of the variables. But for the statistically significant qualitative explanatory variables influencing households' total annual income, their coefficient could be used directly for comparison purpose. Therefore, according to the result of the study in the study area the relative importance of statistically significant explanatory variables influencing smallholder rural farm households' total annual income in descending order are; access to irrigation by 29154.16birr, total livestock holding by 13889.84birr, gender of the household head by 6835.59birr, access to credit facility by 6634.95birr, access to extension service by 4371.16birr and total land holding by 3824.23birr.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Understanding the factors (both socioeconomic and institutional) influencing the households' participation in small-scale irrigation is useful for future policy designs. This study attempts to identify and analyze the determinants of smallholder rural farm households' participation in small-scale irrigation and its effect on income in one woreda of North Gondar zone namely Dembia woreda with five sample kebeles. On the basis of the information collected from 240 households and taking into account all the methodological pitfalls of studying determinants of smallholder rural farm households' participation in small-scale irrigation and its effect on income, 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 and t-tests were applied to statistically compare the two groups for discrete and continuous variables of the model respectively.

The result shows that 53.33% of the total sample respondents were found to be users of small-scale irrigation. Access to irrigation increases the opportunity for crop intensity and diversification, which increase agricultural production and income. Irrigation user households have significantly larger mean annual income as compared to irrigation non-user households. Having access to irrigation had significantly improved the living standards of farming households. In addition to their normal rainfed cultivation, irrigating households cultivate cash crops using small-scale irrigation. The main irrigated crops were onion, garlic, tomato, pepper, potato, lettuce, cabbage and carrot. These horticultural crops were selected due to good production potential, economic returns and ease of cultivation. The main income sources of rural household in the study area were cropping, livestock and off-farm activities.

The regression result in the first stage of the Heckman two stage procedures for the determinants of smallholder rural farm households' participation in small-scale irrigation nine variables were found to be significantly creating variation on the probability of rural farm households' small-scale irrigation participation. The variables that turned out to be statistically significant include: total livestock holding, size of cultivated land, access to extension service, distance from households' farm to the nearest market, level of education of the household head, availability of family labor force, distance from households' residence to the water source, gender of the household head and access to credit facility. Households with large number of family size in adult equivalent have higher probability of participation in small-scale irrigation. Male-headed households have higher probability of participation in small-scale irrigation compared to female-headed households. On the other hand, households with large livestock holding, large cultivable land, credit users and got extension service, literate household heads have high probability of participation in small-scale irrigation positively and significantly. While distance of households' farm to the nearest market and distance of households' residence to the water source negatively and significantly associated with households' participation in small-scale irrigation.

Moreover the results of the second stage of the Heckman two stage estimation showed that access to irrigation, total livestock holding, access to extension service, gender of the household head, size of cultivable land, and access to credit facility are significantly associated with household total annual income. Once they take part in small-scale irrigation activity, male-headed households earn more than their female counterparts. Size of cultivable land holding is positively associated with the level of total annual income among the participant households. Accesses to small-scale irrigation increases mean household income positively and significantly about 29154.16 ETB per year over non-irrigating households. Availability of family labor force is positively related with household annual total income, but its effect is not significant even at 10% significant level.

5.2 Recommendations

Based on the findings what we have got in the analysis part, in both descriptive and econometric analysis, the following policy recommendation remarks can be drawn for further consideration and improvement of irrigation development and income in the district in particular and in North Gondar zone at large.

Though the study revealed that participation in small-scale irrigation increases household income, there are no sufficient sources of water even for those who take part in irrigation. Therefore, the Zonal government has to incentivize farmers to undergo water conservation practices and in addition to surface water the regional water enterprise has to also dig underground water for small-scale irrigation is likely to be valuable for future irrigation development. Moreover some of the irrigating households reported that they face a problem of crop failure while using irrigation. We recommend the responsible body to work hard on the prevention and/or protection of crop disease.

Extension service is a corner stone of agricultural practices in general particularly for irrigation development. Access to extension services was positively and significantly related to both farm households' participation in small-scale irrigation and income. We recommend Agricultural faculties around Ethiopian Universities and colleges to train quality development agents especially irrigation experts in adequate number to the rural areas would increase the contact and flow of information between the DA and farm households to increase their participation in small-scale irrigation, thereby enhance the production and productivity of the rural sector.

The study revealed that the number of livestock holding in terms of TLU influence participation decision of small-scale irrigation and income positively and significantly. Therefore, it should be given due attention to develop the livestock sector at least in the following areas: feed resource improvement and management, genetic resource improvement, protection and/or prevention of animal diseases and parasites and development of marketing facilities for animal and animal products.

The empirical results of this study showed that size of cultivated land is positively associated with farm households' income level and it was one of the most constraining factors. The possibility of its expansion seems bleak especially in the study area. Thus, to mitigate the problem of cultivated land scarcity, the existing land must be intensively used. For this purpose, farmers should rather be encouraged to use intensive agricultural production methods. In this regard, the current effort of the government to promote small-scale irrigation scheme and water harvesting technologies should be further expanded and strengthened in order to enhance farm households' income level.

The gender difference of household heads in irrigation participation and income indicated female-headed households face shortage of labor and market information, made them rent/share out their land to the male headed household heads. As a result the likelihood of participation and income of female headed household heads are less than the male headed household heads. Therefore, the local government has to find out ways to increase their probability of participation and enhance their income. For instance, insuring property ownership (e.g. motor pump) to female-headed households and provide subsidized credits are some mechanism of increasing female-headed household's participation in small-scale irrigation and enhance their income level.

Households in collaboration with the local leaders and other stake holders should invest in the expansion of both formal and informal schools as education is found to be statistically significant in increasing participation in small-scale irrigation.

Moreover 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. Since there is quality deterioration of their products due to lack of efficient storage and post harvest processing mechanisms, farmers sell their products by cheap price during harvest period. Therefore, an effective marketing system will facilitate irrigation participation. Hence, the concerned bodies like governmental extension services, farmers' cooperatives and non-governmental market organizations should support the further development of the efficient marketing systems in the study area. This may include provision of marketing facilities and information provision. In addition to this the local administrative body should establishing irrigation co-operative and integrate to market is crucial in order to the farmers get reasonable price for their produce.

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ANNEXES

Annex 1. Stata output for Heckman two stage model

totinc	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
livestock	1112.968	265.298	4.20	0.000	590.194	1635.742
dismkt	-60.33228	204.6958	-0.29	0.768	-461.5287	340.8641
cultland	1274.743	675.8519	1.89	0.061	-57.03388	2606.52
educ	296.4408	374.509	0.79	0.429	- 437.5834	1030.465
acinfo	1032.005	1238.68	0.83	0.405	-1395.763	3459.772
acirrig	29154.16	2404.707	12.12	0.000	24441.02	33867.3
soilfert	265.6992	1041.313	0.26	0.799	-1775.237	2306.635
sexhead	6835.594	2651.76	2.58	0.010	1638.241	12032.95
famlabor	192.4597	210.7069	0.91	0.361	-220.5182	605.4377
age	284.5491	254.7988	1.12	0.264	-214.8473	783.9455
accredit	6634.947	1405.333	4.72	0.000	3880.544	9389.35
agesquare	-2.841285	2.584904	-1.10	0.272	- 7.907604	2.225034
acexten	4371.16	1816.509	2.41	0.016	810.8674	7931.452
_cons	28003.41	7644.271	3.66	0.000	13020.91	42985.91
acirrig						
dismkt	-.1645865	.064289	-2.56	0.010	-.2905906	-.0385824
educ	.487234	.2154668	2.26	0.024	.0649267	.9095412
dishom	-.2561372	.0986141	- 2.60	0.009	-.4494173	-.062857
acinfo	.8989766	.2874518	3.13	0.002	.3355814	1.462372

livestoc	.1507195	.0617812	2.44	0.015	.0296305	.2718085
soilfert	.1029363	.3116915	0.33	0.741	-.5079677	.7138403
cultland	.1690745	.1599984	1.06	0.291	-.1445166	.4826655
sexhead	1.247815	.4400712	2.84	0.005	.385291	2.110338
famlabor	.1364162	.0603199	2.26	0.024	.0181914	.254641
age	-.0901137	.0843186	-1.07	0.285	-.2553752	.0751477
accredit	.9352274	.2892408	3.23	0.001	.3683259	1.502129
agesquare	.0009357	.0008297	1.13	0.259	-.0006905	.0025619
acexten	1.726107	.3026273	5.70	0.000	1.132969	2.319246
_cons	-1.014941	2.350899	-0.43	0.666	-5.622619	3.592736
mills						
lambda	-3028.9	1433.229	-2.11	0.035	-5837.976	-219.8233
rho	-0.61519					
sigma	4923.5439					
lambda	-3028.8998	1433.229				

Number of obs = 240

Censored obs = 112

Uncensored obs = 128

Wald chi2(24) = 103.66

Prob > chi2 = 0.0000

Annex 2. Marginal effects of the probit model for the determinants of households' participation in small-scale irrigation (Participation equation)

acirrig	dF/dx	Robust Std. Err.	z	P>|z|	x-bar	[95% C.I.]	
dismkt	-.0636426	.0234176	-2.66	0.008	6.55833	-.10954	-.017745
educ	.1884044	.0653208	2.84	0.005	.716667	.060378	.316431
dishom	-.0990435	.0363737	-2.74	0.006	3.69167	-.170335	-.027752
acinfo*	.3372398	.0955075	3.25	0.001	.504167	.150049	.524431
livestoc	.0582805	.0194839	2.99	0.003	6.20908	.020093	.096468
soilfert*	.039952	.0977854	0.41	0.683	.666667	-.151704	.231608
cultland	.065378	.0535042	1.23	0.220	1.57917	-.039488	.170244
sexhead*	.4641474	.1562738	2.43	0.015	.8	.157856	.770438
famlabor	.0527496	.0251128	2.13	0.033	5.91746	.003529	.10197
age	-.0348453	.0306398	-1.12	0.261	47.3875	-.094898	.025208
accredit*	.3545781	.0975279	3.45	0.001	.575	.163427	.545729
acexten*	.6025183	.0784558	5.90	0.000	.529167	.448748	.756289
agesqu~e	.0003618	.0003066	1.17	0.243	2382.75	-.000239	.000963

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

Number of obs = 240

Wald chi2 (13) = 108.78

Prob > chi2 = 0.0000

Log pseudo likelihood = -53.198789

Pseudo R2 = 0.6792

Annex 3. Ordinary least square estimates of model variables

totinc	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
livestoc	615.6734	355.5527	1.73	0.085	-84.91591	1316.263
dismkt	-89.74144	133.5576	-0.67	0.502	-352.9189	173.4361
cultland	675.4948	362.0555	1.87	0.063	-37.92446	1388.914
educ	474.1981	362.7048	1.31	0.192	-240.5177	1188.914
acinfo	-426.7577	712.1178	-0.60	0.550	-1829.997	976.482
acirrig	24735.91	1092.396	22.64	0.000	22583.33	26888.5
soilfert	-700.9242	695.5486	-1.01	0.315	-2071.514	669.6655
sexhead	2327.517	906.883	2.57	0.011	540.4888	4114.544
accredit	3795.75	745.6686	5.09	0.000	2326.398	5265.102
famlabor	-31.85045	144.0327	-0.22	0.825	-315.6691	251.9682
age	209.1007	183.8504	1.14	0.257	-153.1795	571.3809
acexten	2453.094	931.9511	2.63	0.009	616.6693	4289.519
agesquare	-2.212462	1.869589	-1.18	0.238	- 5.896517	1.471594
_cons	17179.77	4722.997	3.64	0.000	7873.024	26486.51

Number of observations	240
F(13, 226)	177.63
Prob > F	0.0000
R-squared	0.9109
Adj R-squared	0.9057

Annex 4. Variance inflation factors for Continuous variables to test multicollinearity

Variable	VIF	1/VIF
livestock	1.06	0.943769
cultland	1.05	0.951715
dishom	1.04	0.958072
famlabor	1.02	0.977092
age	1.02	0.978080
dismkt	1.02	0.983032
Mean VIF	1.04	

Source: Computed from own survey data, (2013)

Annex 5. Contingency coefficient for discrete variables to test multicollinearity

	acirrig	educ	acinfo	soilfert	sexhead	accredit	acexten
Acirrig	1.0000						
Educ	0.3874	1.0000					
Acinfo	0.3920	0.3032	1.0000				
Soilfert	0.1535	-0.0059	0.1650	1.0000			
Sexhead	0.4301	0.2026	0.1500	0.1547	1.0000		
accredit	0.4798	0.2459	0.1757	0.0715	0.0715	1.0000	
acexten	0.7072	0.3346	0.2666	0.1476	0.3840	0.4048	1.0000

Source: Computed from own survey data, (2013)

Annex 6. Conversion factors used to estimate Tropical Livestock Unit (TLU)

Livestock	TLU	Livestock	TLU
Calf	0.2	Sheep and goat	0.13
Bull	1.0	Cow and ox	1.0
Donkey	0.7	Horse/Mule	1.1
Heifer	0.75	Chicken	0.013

Source: Desale (2008)

Annex 7. Conversion factors used to estimate adult equivalent

Years of age	Men	Women
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
14-16	1.06	0.86
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
60plus	0.84	0.74

Source: Haile (2008)

Annex 8. Specification, Hetroskedasticity, and Normality tests for the Model

a) ***Model Specification Test***

Ramsey RESET test using powers of the fitted values of totinc

Ho: model has no omitted variables

F(3, 223) = 18.28

Prob > F = 0.0000

b) ***Test of hetroskedasticity of the error term***

Breusch-Pagan / Cook-Weisberg test for hetroskedasticity

Ho: Constant variance

Variables: fitted values of totinc

chi2(1) = 16.82

Prob > chi2 = 0.0000

c) ***Normality Test of the model***

i) Skewness/Kurtosis tests for Normality

Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
dismkt	0.024	0.193	6.54	0.0381
dishom	0.372	0.014	6.53	0.0381
livestoc	0.129	0.505	2.78	0.2496
cultland	0.004	0.000	25.41	0.0000
famlabor	0.520	0.000	12.03	0.0024
age	0.183	0.195	3.48	0.1756
agesquare	0.000	0.279	17.93	0.0001

ii) Shapiro-Wilk tests for Normality

Variable	Obs	W	V	z	Prob>z
dismkt	240	0.98640	2.380	2.013	0.02204
dishom	240	0.99414	1.026	0.059	0.47634
livestoc	240	0.98713	2.251	1.884	0.02978
cultland	240	0.97385	4.575	3.531	0.00021
famlabor	240	0.98646	2.369	2.002	0.02262
age	240	0.98825	2.056	1.673	0.04713
agesquare	240	0.95257	8.298	4.913	0.00000

iii) Shapiro-Francia tests for Normality

Variable	Obs	W'	V'	z	Prob>z
dismkt	240	0.98787	2.280	1.752	0.03993
dishom	240	0.99524	0.895	-0.239	0.59448
livestoc	240	0.98930	2.011	1.489	0.06827
cultland	240	0.98285	3.225	2.472	0.00672
famlabor	240	0.98913	2.044	1.523	0.06389
age	240	0.99194	1.516	0.891	0.18642
agesquare	240	0.95635	8.207	4.362	0.00001

Annex 9. Semi Structured Survey Questionnaire

The questionnaire is prepared to undertake a study on the ***"Determinants of Smallholder Rural Farm Households' Participation in Small Scale Irrigation and Its Effect on Income at house hold level".*** The purpose of the questionnaire is to gather information on irrigating and non-irrigating households' socio-economic, agricultural and non-agricultural activities, access for services and other important information. Dear respondents, the result of this study will help different stakeholders and policy makers to make appropriate measures on irrigation development in the future. Your responses are confidential. Therefore, you are kindly requested to provide genuine responses. Thank you for your time and cooperation!

1. **Identification Information**

1.1 .Name of Kebele__________________

1.2 .Category of the household(put **X** mark) a) Irrigation user________ b) non-user_______

1.3 .Irrigation Typology(put X mark) a) Modern_________ b) Traditional________

2. **Household Socio-economic characteristics**

2.1. Household head name: ___________________

2. 2. Age of the household head _____________________

2.3 Sex of the household head _____________

1= Male 2 = Female

2.4 Education level of the household head_____________________

0=Illitrate 1= read and write 2= Elementary (grade 1-6) complete

3= Junior (grade 7&8) complete 3= High school and above (grade 9 and above)

2.5 Age and sex of all household members including permanently employed laborer.

Age	Male	Female
0-1		
1-2		
2-3		

3-5		
5-7		
7-10		
10-12		
12-14		
14-16		
16-18		
18-30		
30-60		
60plus		

2.6. Total family numbers of the household________________________________

2.7. Do you face labor shortage?

0 = No 2 = Yes

2.8.Do you have any other occupation in addition to farming?

A. No occupation E. Local beverage

B. Waving F. Selling fire wood

C. Petty trading G. House builder

D. Daily laborer H. Other specify___________________

3. Infrastructure/access to road and irrigation

3.1. Distance from the nearest market place (in km) _____________

3.2. What is the distance between the sources of water to your irrigated land and your home (km)?_____________

3.3. Are you irrigation user? 0 = No 1= yes

3.4. If the answer is No, what is the reasons not using irrigation?

1 = No farmland in surface water access

2 = No information about irrigation

3 = there is enough rain and moisture

4 = others

3.5 How do you transport agricultural produce to the market place?

1. On back --------- 3. Horse cart -----------
2. Vehicle----------- 4. Other specify---------

3.6 How many times do you produce within a year?

3.7 Have you cultivated the total of your irrigable land?

Yes =1 , No = 0

3.8. If your answer for question #3.7 is 'No' what is the reason?(Circle the answer)

1 =Shortage of family labor

2 = lack of seed

3 = lack of oxen

4 =enough production rainfed

5 =lack of credit

6 = others specify

3.8.1. Have you rented in or rented out any cultivable land? Yes =1, No =0

3.9.1 How many years practice irrigation?

3.9.2. What are the common irrigable crops you produce and why you choose these crops?

3.9.3. Have you ever faced a problem of crop failure when using irrigation?

1 = yes, 0 No

3.9.4. If yes why?

A. water shortage

B. Crop disease

C. weed problem

E. Water logging

F.Others specify________________

4. Resource endowments

4.1 Do you possess your own land? Yes =1 , No = 0

4.2 if your answer to question #4.1 is 'yes' what is your total land size in hectare?____________

4.3. If your answer to question #4.1 is 'yes', would you fill the following information?

No	Land Type	Size in timed
1	Currently farmed	
	a. Own	
	b. Rented in	
	c. Rented Out	
	d. Shared cropped in	
	e. Shared cropped out	
2	Fallow land	
3	Pasture land	

4.4. How do you perceive the condition of your land?

1= fertile, 2 = moderately fertile 3= less fertile 4 = infertile

4.5. How did you get your cultivable land? (put X mark)

1. Inherited from family…………
2. Rent (purchased)……………..
3. Government redistribution……….

4.Leased or share cropping……..

5. Others, specify………………..

4.6. Have you rented in (rented out) your plot of land to other farmers? 1.Yes 2. No
And if the answer is yes, what is the reason? 1, Shortage of seed 2, Shortage of ox (en)
3, Disabled 4, others specify

4.7. Do you rear livestock?

1= Yes, 0 = No

4.8. What livestock types and number do you own?

No.	Type of animal	Number of animals
1	Oxen	
2	Bulls	
3	cows	

4	Calf	
5	Heifers	
6	Sheep	
7	Goats	
8	Donkeys	
9	Mules	
10	Horses	
11	Chicken (poultry)	

4.9. 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)………………………

5. Marketing Issue

5.1 Do you produce for market using irrigation?

1=yes, 0 = No

5.2 If your answer to question # 5.1 is 'No', which of the following is?
important reasons for you?

A. No enough water is received for surplus production
B. No enough land for surplus production
C. No enough market demand
D. Other specify ______________________

5.3 What are the problems in marketing your produce?

A. Transportation problem

B. Too far from market place

C. Low price of agricultural out put

D. others specify_________________

5.4 Where do you sell your farm products?

A. On farm (local assembler) C. Through service cooperatives

B. taking to the local market D. Others specify

5.5 Did you get reasonable price for your produce at the place you used to sell to?

1 = yes, 0 = No

5.6 If your answer to question #5.5 is 'No' what are the reasons?

A. No demand for the produce

B. More supply of the produce

C. Others specify____________

5.7 Do you get market information about prices and demand conditions of agricultural inputs and out puts?

1 =yes , 0 =No

5.8. Do you have Mobile and/or Radio? 1. Yes……………… 2. No…………

5.9. Do you listen to agricultural program on Radio? 1. Yes……………2. No………..

6. Extension issues

6.1 Do you receive any sort of extension services available in your locality?

1 = yes , 0 No

6.2 Do you receive support from DAs?

1 = yes ,0 = N0

6.3 If your answer to question #6.2 is ‘yes’what are the supports given?

A. Advice D. Conflict resolution

B. Training E. Controling water distribution

C. Demonstration F. Specify others

6.4 How many days contact the DA’s per month?________

6.5 Do you participate in extension package program?

1 = yes, No = 0

6.6 If your answer is ‘yes’ how many years did you participate in the extension package program?

7. Access to credit Issues

7.1 Did you need credit for the production of your agricultural products?

1 = yes, 0 = No

7.2 If yes, did you have access to credit for the production of the Commodities?

0 = No , 1 = Yes

7.3 If yes what are the sources?

A. Banks D. Friends/relatives

B. Traders E. Micro finance

C. Local lenders F. Others specify ________

7.4 If no why?

A. High interest rate C. Not available on time

B. No need D. Shortage of money for down payment

E. Other, specify________________

7.5 Is credit timely and adequately available for agricultural commodities development?

0 = No 1 = Yes

7.6 What is the distance between your home and the formal financial institution (in km)?______

7.7 Do you get any remittance and/or aid?

7.8 If 'yes' how much remittance and aid in birr respectively? ________________ &____________?

8. Household Expenditure

(Food and Non-food expenditure)

Commodity		Quantity		Unit	Value in ETB		Tot. Exp
		Own production	Purchased or other source		Own production	Purchased	
Teff	1						
Wheat	2						
Sorghum	3						
Millet	4						
Maize	5						
Barley	6						
Bean	7						
Chick pea	8						
Field Pea	9						
Linseed	10						
Nuge	11						
Sunflower	12						
Others, Specify	13						

Pepper	14						
Carrot	15						
Cabbage	16						
Lettuce	17						
Tomato	18						
Potato	19						
Onion	20						
Garlic	21						
Others,Specify	22						
Live stock purchase	23						
Batteris	24						
Alcohol	25						
Hair food	26						
Kerosene	27						
Matches	28						
Charcoal	29						
Radio	30						
House rent	31						
Water	32						
Transport	33						
Communication(Telephone)	34						
Electricity	35						
School fees	36						
Other educational expense(uniform,books,pen, etc)	37						
Cooking oil	38						
Sugar	39						
Coffee	40						
salt	41						

Fruits	42						
Other major weekly purchase(specify):	43						
Fertilizer(not on credit;cash only)	44						
Seed	45						
Herbisides/pesticides	46						
Livestock fodder/feed	47						
Clothes/shoes for Women	48						
Clothes/shoes for Men	49						
Clothes/shoes for Children	50						
Health expenses	51						
Soup/Washing Powder	52						
Festivals/weddings/funerals	53						
Building materials	54						
Contribution to Iddir	55						
Donation to the church	56						
Taxes and levies	57						
Compensation and penalities	59						
Voluntary contribution	60						
Gifts to other households	61						
Other major expenses(Specify):	62						
Other major expenses(Specify):	63						
Other major expenses(Specify):	64						

Thank you for your time and cooperation!