Indira Gandhi National Open University (IGNOU)

IMPACT OF SMALL SCALE IRRIGATION ON THE LIVELIHOOD OF RURAL FARM HOUSEHOLDS:

The case of Enderta District in Tigray Region, Ethiopia

By

Gebremeskel Gebremichael Gebregziabher

November, 2013
Addis Ababa

Indira Gandhi National Open University (IGNOU)

IMPACT OF SMALL SCALE IRRIGATION ON THE LIVELIHOOD OF RURAL FARM HOUSEHOLDS:

The case of Enderta District in Tigray Region, Ethiopia

A Thesis submitted to Indira Gandhi National Open University in partial fulfillment of Master's Degree of Arts
In
RURAL DEVELOPMENT

By

GEBREMESKEL GEBREMICHAEL GEBREGZIABHER

Enrolment No: - 099122160
Mobile Number: *- +251 914746962*
Email: - *gebremeskel29@yahoo.com*

ADVISOR: WONDIMAGEGNE CHEKOL (Ph.D)

November,2013

ACKNOWLEDGMENTS

Above all, I would like to extend my unshared thanks to the almighty God for his untold and all time grace that gave me enthusiasm to start and finish this thesis work.

I am indebted and gratefully acknowledge to my advisor Dr. Wondimagegne Chekol for his respectful reception and devotion of his precious time to provide constructive comment and encouragement thorough out of this research.

I would like to thank my friend Mr.Tadesse Demewez for his support that took time to read and comment on this thesis. I would like also to thank the sample respondents, members of focus group discussion, Development agents, and Agriculture and Rrural Development and Water Resource Offices of Enderta for their valuable cooperation during data collection and gathering important information.

My special gratitude goes to my brother Mr. Teklay G/her for his unreserved moral and invaluable support in the course of my entire academic endeavor.

Finally, I am indebted to my dear wife Amleset, my beloved son Eyuel and all my family for their constant encouragement, inspiration and patience throughout my study period.

TABLE OF CONTENTS

CONTENTS **PAGE**

LIST OF TABLES

TABLE'S **PAGE**

LIST OF FIGURES

FIGURES **PAGE**

LIST OF PLATES

PICTURES **PAGE**

LIST OF MAPS

MAPS **PAGE**

ACRONOMYS AND ABBREVATIONS

BoARD	Bureau of Agriculture and Rural Development
BoFED	Bureau of Finance and Economic Development
CSA	Central Statistics Authority
DA	Development Agent
DFID	Department for International Development
EARDO	Enderta Agricultural and Rural development Office
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
GTP	Growth and Transformation Plan
Ha	Hectare
HH	Household
Km	Kilo meter
M.a.s.l	Meter above sees level
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and rural Development

MWR	Ministry of Water Resource
NGOs	Nongovernmental Organizations
O&M	Operation and Maintenance
PAs	Peasant Associations
PSNP	Productive Safety Net Program
REST	Relief Society of Tigray
SAERT	Sustainable Agricultural and Environmental Rehabilitation of Tigray
SSA	Sub Saharan Africa
SSI	Small-scale Irrigation
SPSS	Statistical Package for Social Science
TLU	Tropical Livestock Unit
WUA	Water User's Associations

ABSTRACT

Irrigation is one means by which agricultural production can be increased to meet the growing food demand in Ethiopia. Small scale irrigation is becoming the main mechanism in livelihood enhancement discourse especially in recent times when the rainfall pattern is becoming erratic in the country. The study examines the impact of small scale irrigation on the livelihood of rural farm households in Enderta district, Tigray regional state, Ethiopia. It focuses on how small scale irrigation could improve the livelihood assets of farmers. The study also looks at factors that affect small scale irrigation. To address the objectives of the study household survey, focus group discussion, informant interview and fieldwork observation were used to collect data at community, household and individual levels. The analysis is undertaken using statistical tools such as mean, percentage values, maximum minimum, and t- test, on top of qualitative analysis.

The findings of this study revealed that there is significance difference in income of crop production in irrigation user than non irrigation user households at 5% level of significance of 3.2 t-value. However the non irrigation user households compensated through higher income from off farm and nonfarm activities. There is no significance difference in annual household income between the irrigation user and non irrigation user households. This shows that the irrigatiion households are not effectively utilizing the irrigation scheme to increase their income due to various factors. The main irrigation constraints are inadequate farmers' knowledge and experience on irrigation development, water loss through unstable canal, lack of water users' committee that manage the irrigation scheme, water logging, and input supply and use.

Key words: *Livelihood, Small scale irrigation, water users' committee, household, income*

CHAPTER ONE

INTRODUCTION

1.1 Background

Ethiopia is predominantly an agrarian country with the vast majority of its population directly or indirectly involved in agriculture. Agriculture in the country is mainly rainfall dependent, traditional and subsistence with limited access to agricultural technologies and institutional support services (Desta, 2004).

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

Ethiopia endows water resources which have 12 river basins with an annual runoff volume of 122 billion m^3 of water and an estimated 2.6 - 6.5 billion m^3 of ground water potential, which makes an average of 1575 m^3 of physically available water per person per year. However, out of 4.3 million hectares of irrigable land only 5% is under utilization in the country. This shows indirectly that most of the water resource of Ethiopia is underutilized though irrigation agriculture is taken as a main strategy to tackle the problem of the growing demand for food crop production in Ethiopia (Seleshi et al. 2007).

The dependence of most of the farmers on rain-fed agriculture has made the country's agricultural economy extremely fragile and vulnerable. Due to rainfall variability in drought porn

parts of the country there is a partial or a total crop failure which causes mostly food and feed shortage (MoWE, 2011).

During the last twenty or more years, millions of Ethiopian households have been suffering from continuing misery, characterized by recurrent droughts that led to shortage of food and severe famine and high levels of malnutrition and food insecurity. Among various region of the country, Tigray Regional state is one of the areas that were severally affected by frequent droughts. In this Region, about 621,000 households, constituting about 75 %, of the total population is food insecure and seriously threatened by recurrent drought, which hit the region every 3-4 years (Hagos, 2003). This is one of the major challenges in rural development as well as how to promote food production to meet the ever-increasing demand of the growing population under the situation of variable and erratic rain falls in the Region.

Thus, exploiting of the irrigation potential of the country in general and the region in particular has been taken as major component of the Growth and Transformation Plan (GTP) of the country to increase agricultural production and productivity through promoting and construction of irrigation infrastructure.

In response to severe environmental degradation, population-resource imbalance and food insecurity the Regional Government of Tigray has initiated different rural development programs at household level. Among others small scale river diversions and micro dam construction through different projects (Sustainable Agricultural and Environmental Rehabilitation of Tigray (SAERT) and Relief Society of Tigray (REST)) were initiated since 2004. Since May 2004, 86 Small scales and 41097 Water Harvesting Schemes were constructed in different parts of Region (Seleshi et al, 2007).

In the last 10 years, a massive scale up of micro-level water harvesting and diverting development in Ethiopia such as above ground tanker, ponds, earth dam, bore holes, shallow wells, deep well runoff diversion and river diversions are found in different places used for different purposes: particularly in food insecure localities.

Irrigation has many functions such as increases crop production and achieves higher yields, and reduces the risk of crop failure if rain fails. It also multiplies the positive effect of other inputs such as fertilizers and pesticides on crop yields. Because small scale irrigation makes households to generate more income, raise their resilience, and in some cases change their livelihoods. With increased investment in the country's irrigation infrastructure and water management practices, resources could contribute significantly to increasing agricultural production and productivity (Hussein and Hanjra, 2004).

Small scale irrigation development has shown throughout the developing world that it can be used as a key drought mitigation measure and as a vehicle for the long-term agricultural and macro-economic development of a country. Successful small scale irrigation schemes can result in increased productivity, improved incomes and nutrition, employment creation, food security and livelihood improvement. However, assessment of small scale irrigation schemes is needed in order to be able to identify their performance and specify their factors of efficiency and also help for future irrigation development.

1.2 Statement of the problem

Agricultural production in Ethiopia is primarily rain fed, 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.

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. In order to respond to growing food demand, food production should increase. The three methods to increase food production are: increasing agricultural yield, 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).

The development of water resources for agricultural purposes (irrigation) is rising rapidly. According to BCEOM (1998) Ethiopia had an estimated total of 161,000 hectares of irrigated agriculture, of which 64,000 hectare is in small-scale schemes, 97,000 hectare is in medium-and large-scale schemes and approximately 38,000 hectare is under implementation. Currently, the Ethiopian government gives more emphasis to small-scale irrigation as a means of achieving food self-sufficiency (MOFED 2010). .

As stated by Banik (2006), there is the need to sincerely question the effectiveness of current development efforts. It is worthy to assess to, how, the already existing small scale irrigation schemes, have been performed in terms of improving upon the livelihoods of the people as an immediate intervention measure as well as their long term viability for the communities utilizing them? The assessment of the effect of the irrigation scheme to the improvement of the lives of the people in the Enderta District of the Tigray Region of Ethiopia with evidence from the Semha scheme, delimited the scope of this study. The selection of the irrigation scheme for this

study is determined partly by the fact that it can be used by a large section of the rural people in the respective communities in the district.

According to Enderta district bureau of agriculture report (2012/13) the irrigation area of the district is 7696ha that have 12881 household beneficiaries. Semha diversion was constructed in 2004 G.C with the discharge capacity that can irrigate above 80hectares of land. At this time the scheme is irrigating 48ha of land for 281 beneficiaries. Like any other irrigation beneficiaries, the household of the study area are expected to be benefited from the irrigation scheme.

However, most of the households of the irrigation scheme did not observed to utilize the irrigation opportunity and many of them are still reliant on food aid and Productive Safety Net Programme (PSNP) rather to utilize being become the irrigation potential beneficiaries.

Based on this the researcher has intended to assess the effect of small-scale irrigation on the livelihood of farm households of the study area.

1.3 Objectives of the study

1.3.1 General Objective

The overall objective of the study is to assess the impact of small scale irrigation on the livelihood of rural farm households of Enderta district.

1.3.2 Specific objectives of the study are:

- ✓ To lookout the impact of small scale irrigation on the livelihood assets of farm households
- ✓ To identify the basic factors that influence small-scale irrigation utilization by the farm households
- ✓ To suggest possible solutions for future planning and implementation

1.4 Research Questions

In order to address effectively the above stated study objectives a set of research questions are raised to guide the research process.

- ✓ To what extent does the small scale irrigation contributes in improving livelihood assets of the farm households?
- ✓ What advantages can be derived from the small scale irrigation participation?
- ✓ What is the farmers' perception on the contribution irrigation to their livelihood?
- ✓ What are the basic factors that influence small-scale irrigation in the study area?

1.5 Scope of the study

The study is conducted on one small scale irrigation site. It is in small scale and limited mainly focusing on irrigators and adjacent non irrigators that can represent irrigation areas of similar scale but it may be difficult to apply to other large scale irrigation areas. Major focus is given to the impact of river diversion base small scale irrigation on the livelihood assets of farm house holds and factors that affect their utilization from irrigation in the study area.

1.6 Limitations of the study

The study focused on households of a specific area community. Therefore, the selected sample household heads may not adequately represent the characteristics of all other diversified rural irrigation user farmers.

The study focuses on river diversion only that might not applicable for dams in case of siltation and outlet operation problems.

In addition, detail information on household material possession and incomes may not perfect and covered by the study.

1.7 Significance of the study

Irrigation could serve as a viable solution to address the problem of food insecurity by boosting agricultural production. Based on this premise, in Ethiopia and in other parts of the world, large, medium and small-scale irrigation schemes have been constructed and made available for increasing agricultural production and productivity.

Development researchers have emphasized that irrigation enables to increase income for farmers, create employment opportunities and increase foreign exchange earnings (Desalegn 1999:9). However in many parts of Africa and in Ethiopia, most of the areas intervened by such infrastructure development are still being reported to be suffering from shortages of food supply.

The study is intended in identifying, analyzing, and documenting the socio-economic and institutional factors affecting irrigation development that contributes its part to the existing body of knowledge. Secondly, it provides a base for decision makers through the comparisons of positive and negative effect of irrigation with respect to similar areas in specific. Thirdly, it provides directions for further research, extension and development schemes that will improve the benefit from irrigation.

1.8 Organization of the paper

The paper is organized into six chapters. The first chapter introduces the background of the study, statement of the problem, objectives of the study, research questions, significance and the scope of the study, limitations and organization of the study. The second chapter deals with the review of related literatures. The third chapter describes the background of the study area. The

fourth chapter constitutes the materials and methods. Chapter five describes on the results and discussions of the study. The chapter describes socio-economic aspects of the irrigation user and non irrigation user households in the study area; effects of irrigation on the human, natural, financial, physical and social livelihood capitals and the factors that affect the small scale irrigation. And in chapter six a summary and conclusion is made by addressing the main issues, problems and findings of the study.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Irrigation

Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation water is supplied to supplement the water available from rainfall and the contribution to soil moisture from ground water. It is a means by which agricultural production can be increased to meet the growing food demands through increasing agricultural yield, increasing the area of arable land, and increasing cropping intensity. It is a socio-technical event where farmers have major controlling influence and a means by which agricultural production can be increased to meet the growing food demand through artificial means in the absence or presence of rainfall by reducing water stress on crops. Irrigation is a method by which land moisture may be maintained by supplying water to the intended farmland. In this case, water for agricultural production can be sought from flowing rivers, collection of rainwater by building dams and reservoirs and pumping up from the ground. (Michael 1997:1)

2.1.1 Irrigation development

Irrigation is an ancient agricultural practice which was extensively used by a number of early civilizations such as the ancient Egyptians, (Grove, 1989). Punnet (1982) argued that irrigation has been carried out for centuries around the globe and it started with traditional methods like the Sakia and Shaduf Ancient civilizations developed rivers that supplied water for farming. Troeh et al (1980) said that as early as 500BC the Egyptians cultivated land made fertile by the flood waters of the Nile River. By about 3000BC they had built Canal system that carried water from the Nile to their fields. This was after the realization that they had been recurrent droughts in

Egypt and many dry parts could not reserve enough food for the whole year. Large irrigation systems also had been constructed by that time in parts of China, India and South-west Asia. According to Miller (1982), irrigation therefore facilitated the growing of crops in the flood plains of the Nile valley so that supplementary food could be accessed. An increase in crop production in almost every year as a result became the attracting feature for the country to increase irrigated lands. Recent years has seen an increase in the use of irrigation to facilitate cultivation in semi-arid and arid regions.

Irrigation is an age-old art in Nile valley. It was practiced for thousands of years in the Nile Valley. Egypt claims to have the world's oldest dam built about 5000 years ago to supply water for house hold purpose and irrigation. At that time basin irrigation was introduced and still plays a significant role in Egyptian agriculture. Zewdie et al. (2007) indicated in their study that irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. India and Far East have grown rice using irrigation nearly for 5000 years. The Nile valley in Egypt, the plain of Euphrates and Tigris in Iraq were under irrigation for 4000 years. Irrigation is the foundation of civilization in numerous regions. Egyptians have depended on Nile‟s flooding for irrigation continuously for a long period of time on a large scale. The land between Euphrates and Tigris, Mesopotamia, was the breadbasket for the Sumerian Empire. The civilization developed from centrally controlled irrigation system (Schilfgaard 1994).

Evidence also shows that irrigation in China was begun about 4000 years ago. There were reservoirs in Sri Lanka more than 2000 years old. As far back as 2300 BC, the Babylonian Code of Hammurabi provided that 'If anyone opens his irrigation canals to let in water, but is careless and the water floods the fields of his neighbor, he shall measure out grain to the latter in proportion to the yield of the neighboring field.' Other indicator for irrigation development is

found in the stony-gravel limestone desert of the Negev area in Israel. Remnants of these ancient irrigation systems date back from the Israelite period (about 1000 BC) and from the Nabattean-Roman-Byzantine era (300 BC to 600 AD). In the absence of permanent water sources, the ancient farmers developed 'runoff' farm systems that used sporadic flash floods for irrigating (Shanan 1987).

2.1.2 Importance of Irrigation

Modern technology spurs ways for confronting the effect of natural and man-made disasters by using irrigation development structures. Hence, a number of advantages of irrigation are known, some of which are briefly presented below:

a) Irrigation enables to bring uncultivated lands under cultivation. Bhargavea (1980:48) states that irrigation facilitates extending the area of land under cultivation,

b) The use of irrigation contributes to stabilize fluctuation in food supply. Scientific management of irrigation water provides the best insurance against weather–induced fluctuations in total food production (Michael, 1997:3)

c) Irrigation facilitates agricultural production intensification. FAO (2000: xii) described that irrigation scheme helped to increase agricultural productivity of a given land in Africa such as in Zimbabwe, and this can be explained by the level of input needed and utilized.

d) Irrigation helps to diversify product types. Many research findings (FAO, 2000) attempts to prove that choices of crop types could be facilitated by irrigation and increase food variety and availability.

e) Irrigation can facilitate to provide alternative cropping pattern decision between cash and food items (FOA, 2000: 10).

f) Irrigation provides the chance for increasing income. It is found that existence of irrigation can increase income by creating more employment since it is labour intensive. Irrigation can create or increase employment opportunities especially, surface irrigation is found to be labour intensive FAO (2000).

g) Irrigation makes it possible to grow cash crops, which give good returns to the cultivators than the ordinary crops they might have grown in the absence of irrigation FAO (2000).

h) Irrigation in Ethiopia is basically used for mitigating the negative impacts of drought in susceptible to danger areas (Desalegn, 1999:43). Moreover Desalegn argue that with sound management and careful planning, irrigation use can improve the livelihood of rural poor.

2.1.3 Water Resource and Irrigation in Ethiopia

Ethiopia has a long history of traditional irrigation systems. Simple river diversion still is the dominant irrigation system in Ethiopia. According to Gebremedhin and Peden (2002), the country's irrigation potential ranges from 1.0 to 3.5 million hectares but the recent studies indicate that the irrigation potential of the country is higher. According to Awulachew et al. (2010), estimate, the irrigation potential of Ethiopia is 4.3 million hectares. In Ethiopia traditional irrigation schemes cover more than 138,000 hectares whereas modern small-scale irrigation covers about 48,000 hectares.

The total annual water resource of the country is estimated at 122 km3, of which 76.6 km3 drain into the Nile basin. The usable ground water resource is estimated to be 2.6 km3. There are 12 major river basins that have their own irrigation potential. Most of them flow to Sudan, Eritrea, Lake Turkana and Somalia except Awash basin, which is endorsee (FAO, 1995).

Table 2.1 Irrigation potential in the river basins of Ethiopia

Basin	Irrigation potentials (ha) (Respective recent master plan studies)			
	Small scale	**Medium scale**	**Large scale**	**Total**
Abay	45,856	130,395	639,330	815,581
Tekeze	N/A	N/A	83,368	83,368
Baro-Akobo	N/A	N/A	1,019,523	1,019,523
Omo-Ghibe	N/A	10,028	57,900	67,928
Rift Valley	N/A	4,000	45,700	139,300
Awash	30,556	24,500	79,065	134,121
Genale-Dawa	1,805	28,415	1,044,500	1,074,720
Wabi-Shebele	10,755	55,950	171,200	237,905
Denakil	2,309	45,656	110,811	158,776
Total				**3,731,222**

Source, IWMI, 2010, Water resource potential in Ethiopia

The challenge that Ethiopia faces in terms of food insecurity is associated with both inadequate food production even during good rain years (problem related to growth of population), and natural failures due to erratic rainfall. Therefore, increasing arable land or attempting to increase agricultural yield alone cannot be a means to provide food security in Ethiopia, due to environmental impacts (expansion into marginal land, deforestation) and unpredictable natural factors (climate). Ethiopia has also to combine these with enhancing water availability for production and expansion of irrigation that can lead to security in terms of getting a reliable harvest as well as intensification of cropping (producing more than one per year). This should be combined with improved partitioning, storage and soil water-retention capacity to increase plant

water availability, and use of rainwater to overcome erratic rainfall especially in the relatively higher rainfall areas of highland Ethiopia. There are also important other ways to reduce risk for farmers (social, economic, spatial diversity) and for the government (trade, buffer, pricing), Awulachew et al (2005).

Irrigation and improved agricultural water management practice could provide opportunities to cope with impact of climatic variability enhance productivity per unit of land, increase the annual production volume significantly. Irrigated agriculture started in Ethiopia in the 1960 with the objective of producing industrial crops (sugar cane and cotton) on large-scale basis. In the country farmers however, had already been practicing irrigation by diverting water from rivers in the dry season for the production of subsistence food crops as traditional irrigation. The experience in modern small-scale irrigation (SSI) development and management started in the 1970s by the Ministry of Agriculture (MoA), in response to major droughts, which caused wide spread crop failures and consequent famine. The sector could be used to reduce family risks that are associated with crop failures resulting from droughts. Currently government gives emphasis to develop the sub-sector to fully tap its potentials by assisting and supporting farmers to improve irrigation management practices and the promotion of modern irrigation systems, Teshome Atnafie (2006). Although irrigation potential in Ethiopia is estimated at 3.7 million hectares under conventional gravity irrigation, if rain water harvesting and supplementary irrigation, ground water use, and water lifting technologies are considered, it is believed that the potential could be more than the estimated hectares. The current level of irrigation development is about 250,000 hectares, with further planned for implementation.

According to Teshome Atnafie (2006), currently, irrigated agriculture produces less than 3 percent of the total food production of the country, which is very low. Thus the government has

revised its strategy for irrigation development with the target to added 274,612 hectares by 2016, Awulachew et al (2005), the ministry of water resources is currently undertaking a total of thirteen irrigation projects located in different parts of the Country. They constitute approximately a total area of 493,603 ha and envisaged to be completed before the end of the irrigation development program planning period in 2016, Teshome A. (2006). This revised target is mainly related to large and medium scale irrigation and it is expected that the small scale irrigation sub-sector which is under the Ministry of Agriculture and Rural Development will also strive similar targets.

Although irrigation has long history in Ethiopia, the traditional small-scale schemes are simple river diversions. The diversion structures are rudimentary and subject to frequent damage by flood. 'Modern' irrigation was started at the beginning of the 1960s by private investors in the middle Awash valley where big sugar estates, fruit and cotton farms are found. With the 1975 rural land proclamation, the large irrigated farms were placed under the responsibility of the Ministry of State Farms. Almost all small-scale irrigation schemes built after 1975 were made into Producers' Cooperatives.

Over the last decade government agencies and NGOs have intervened to develop new irrigation schemes and improve the indigenous irrigation schemes by constructing more stable hydraulic structures. However the focus mainly on the development of physical structures not on the software and extension works that highly affects the sustainability of the irrigation schemes.

2.1.4 Types of Irrigation and their Selection

There are different types of irrigation schemes: for instance, traditional and modern. Traditional irrigation schemes were developed in different parts of the world by communities as a response to climatic challenges over time. Since there can be different criteria for dividing such

interventions, a number of classification can be drawn. For example, irrigation schemes can be classified on the basis of their structure, into two groups: River diversion and Dam construction. Others distinguish between *intensive* versus *extensive*; yet other divisions can be made as productive versus protective irrigation systems (Rees Ton & Kees Dejong, 1991).

As regards the ways of supplying irrigation water to the farm, the following four types are identified:

- Sprinkling or spray irrigation;
- Drip irrigation;
- Furrow irrigation and
- Flood irrigation.

Modern irrigation systems basically serve the same purpose as those of traditional systems, except the differences in their technological advancement. Modern irrigation systems are well designed and studied with the aim of securing their sustainability and productivity. Moreover, it can be designed in a way it can serve multiple purposes flexibly according to the prevailing policy, market conditions, consumer tests and other comparative advantages.

Irrigation structures can also be divided into different scales based on their irrigating potential of a given land. As stated in Desalegn (1999) and used in Ethiopia, these are:

a) **Small -scale irrigation (SSI**) schemes conventionally, are those with the discharge that can water up to 200 hectares of land.

b) **Medium-scale irrigation (MSI)** schemes are those that can supply adequate amount of moisture to an area of 200-3000 ha of land.

c) **Large-scale irrigation (LSI)** schemes are those that can secure irrigation water availability to the land size more than 3000 ha

In fact, some countries use other dimensions to categorize irrigation schemes in to different scales: such as the number of beneficiaries and also, the size of land to be irrigated by each scale can be different according to the condition of the respective countries.

Existence of different types of irrigation dictates the importance of selecting appropriate ones. To this effect, the background information about the intended target area must be incorporated. As a rule of thumb, parameters must be established to measure the viability and feasibility of each type of irrigation scheme.

Relevance of irrigation development for specific areas should be considered since, blanket approach of development are leaving floor to local development activities with the aim of increasing efficiency and maintain sustainability. In this line, feasibility of small-scale irrigation schemes for poor countries can be justified from various angles.

Recommended types of irrigation for developing countries, given low-level of technical development, poor financial resource, under-developed market system, poor access to maintenance of them, short-term impacts, and limited government capacity, is small-scale irrigation System.

2.1.5 Small scale irrigation

Small Scale: this involves irrigation activities on small plots, comprising a small number of farmers, using relatively small reservoirs- rivers, dams or a cluster of wells controlled by the farmers using technology they can operate and maintain. 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, micro dams constructed by traditional communities with local means such as stone and brushwood.

Rural Ethiopia exhibits a huge variation along a number of social and economic dimensions: ethnic group, religion, and economic status are just there, Awulachew et al (2005). After infrastructure development such as roads, investments in irrigation are a key factor triggering rural improvement. Moreover, the potential multiplier effects of investments in agricultural intensification are considerable. Studies in India and elsewhere reveal that for each dollar invested in agriculture, the value of economic activity in forward and backward linkages including input supply, trade, export, and processing adds another two dollars return. However, for these benefits to be realized especially in the African smallholder context, smallholder irrigation must satisfy the following conditions (Shah et al., 2002):

- Irrigation must hold out a promise of making significant improvements in the livelihoods and food security situation of the irrigation farmers, i.e., it must be central in their livelihood strategies, and a large proportion of household income must come from irrigation (this relates to optimal plot sizes, crop choices, etc. that enhance viable production);
- The cost of sustainable farmer management of the schemes (including infrastructure, technology, water user associations, etc.) must be an acceptably small proportion of the income derived from irrigation, i.e., benefit cost ratios must give incentives that facilitate rational production decisions;
- The schemes must have a certain level of access to institutional support services, including access to inputs, output markets, credit, extension, institutional framework defining and enforcing secured and use rights to land and water.

Why small-scale?

Small-scale systems may have advantages over large-scale systems. These advantages include that small-scale technology can be based on farmers existing knowledge; local technical, managerial and entrepreneurial skills can be used; migration or resettlement of labour is not usually required; planning can be more flexible; social infrastructure requirements are reduced; and external input requirements are lower (Underhill 1990).

Except for a few countries in northern Africa, Madagascar and South Africa, the potential for irrigation development has not been effectively tapped in Africa. Out of a total arable land of about 874 million hectares (ha), the current area under managed water and land development totals 12.6 million ha, or 3.7 % of the surface area of SSA. In spite of this potential, and the demand for more dependable sources of water, the development of irrigation has not picked up. Furthermore, existing irrigation farms operate at sub-optimal levels. Until recently, irrigated agriculture was almost exclusively supported by the state.

However, government-managed (large- and small-scale) schemes have generally performed far below expectations and most of the time, initial capital costs have not been recouped and the financial returns have not been able to cover operation and maintenance (O&M) costs.

Meanwhile, privately developed and managed (small-scale) irrigation schemes in most of the SSA countries show that there is business potential for private entrepreneur involvement in irrigation. Groups of farmers or water users' associations (WUAs) running parts of irrigation schemes for which responsibility was transferred to them by government, can also be considered as operating private irrigation schemes. Recent developments have shown the increasingly important role of these new operators. However, for private operators to function efficiently a clear institutional framework is required in many parts of SSA this framework is not in place.

In addition to the above, small-scale irrigation schemes are also being promoted because of the associated benefits listed below:

- Lower investment costs
- Ease in maintenance
- End-users being able to have more control of the water they need
- The possibility of remote areas (where there are poorer farmers) gaining access to controlled water
- Small-scale irrigation requires very little in terms of enterprise and management capability
- Their potentially less negative environmental impact.

Small-scale irrigation (those schemes under the direct management of smallholders) will also enable farmers (those outside of the major irrigation perimeters and who would otherwise have to depend on irregular and variable rainfall) to increase crop intensities through double cropping, through supplementary watering during drought, as well as enable crop/forage growth in dry areas (crop expansion). This type of irrigation may take many forms of water control:

- Rainwater harvesting
- Flood recession
- Flood water spreading
- River diversion
- Treadle pumps
- Motor pumps usually combined with sprinkler or drip systems
- Porous jars.

In short, access to small-scale irrigation technology will allow small-scale farmers to improve their livelihood through increasing their production more easily.

2.1.6 Factors Affecting Irrigation Development

There are several factors affecting contribution of small scale irrigation agriculture to livelihood of rural farmers. They include the lack of policy on agriculture and irrigation, lack of financial resources, lack of proper training, lack of adequate market for produce, and lack of appropriate technology irrigated agriculture. There is often lack of commitment and ownership by members of communal irrigation schemes.

The successes of SSI generally depend on the cooperation of larger range of government institutions and individuals, such as, for instance, the departments of irrigation, extension and rural works, banks and planning bodies. Unsurprisingly, development issues are interrelated and water resource developments by nature have interrelation with many factors.

Consequently, irrigation developments are also determined by many factors for their success. As stated by Brown Nooter (1995), the performance of irrigation schemes depends on cropping pattern, market accessibility, maintenance and spare parts, social and political, and land tenure policies. Some major factors that negatively affect irrigation development are:

a) Salinity: in the long term irrigation can increase the salt content of the soil and may cause the land not to be used for cultivation any more

b) Siltation: it is the process of filling canals and reservoirs with soil and sands leached from their respective up streams mostly due to poor catchments management.

c) Depletion of water resource and dependent life systems (i.e., ecological problem of surface and ground water development for marginal water quality areas).

d) Conflicts (e.g., trans-boundary, between upper and downstream users, between management and users, implementers and donors etc) (Desalegn, 1999).

e) Flood and erosion: appropriate surface drainages and effective operation are, therefore, critical for productive and sustainable irrigation in particular since canals are long, and it is difficult to adjust head diversions. Since some are vulnerable to excess water, irrigation-system must be responsive not only to the problems of little rainfall but also to problems of too much rain.

f) Drainage challenges, renewability issues, seepages, canal lining, theft and vandalism of control structures (Donald Campbell, 1995: 7).

g) Market prices for crops: irrigation projects may exhibit negative net present value (NPV) upon implementation due to change in market prices of goods from what is expected during the time of feasibility studies.

h) Change in interest rate: such huge investments are sensitive to cost of capital fluctuations.

i) Maintenance challenges and quality of design: the quality of design and maintenance system can also determine their sustainability.

j) Pest infestation and input shortages: are also some of the areas of concern due to their significant contribution as a threat.

k) Water born diseases: resulting from an irrigation projects are examples of diseconomies/ external costs imposed by the project to the society.

According to (Mekuria T. 2003) the problems related to irrigation development and management in SSA can be categorized as follows:

Environmental factors:

- water scarcity and poor water quality especially as related to sediment concentration;

- land degradation as a result of poor O&M activities – this is partly related to inefficient water management resulting in water wastage and water logging as well as land-use regulation.

Capacity of the farmers:

- lack of know-how in, and access to, the opportunities of irrigation technology;
- weak economic base of most farmers and the relatively high development costs involved in developing irrigation schemes.

Government policy; institutional and legal support:

- limited or no priority given to irrigation development during national and local planning and budgeting;
- poor management structures in place to support farmers and promote irrigation development. For example, the infrastructure to facilitate agricultural development is underdeveloped;
- a land tenure system that does not encourage farmers to invest in permanent improvements on their plots and make improvements which can be used to obtain credits for further development;
- unclear water rights and their enforcement.

Despite the myriad of problems facing formal small-scale and traditional irrigation WUA or cooperative societies, they can become more efficient and sustainable by:

- Upgrading small-scale irrigation techniques
- Putting in place a management structure responsive to water users
- Access to (innovative) credit schemes
- Good support services.

Government's role in supporting irrigation development is therefore important in terms of the policies and regulations formulated and implemented; the planning undertaken at the macro and micro levels; training and; provision of services to support development of the sector.

2.2. Livelihood

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. Livelihood includes human, social, natural, physical and financial assets. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. (Chambers & Conway, 1991)

In order to better understand how people develop and maintain livelihoods, the UK Department for International Development (DFID), building on the work of practitioners and academics, developed the Sustainable Livelihoods Framework (SLF). This framework is an analysis tool, useful for understanding the many factors that affect a person's livelihood and how those factors interact with each other. The SLF views livelihoods as systems and provides a way to understand:

1. The assets people draw upon
2. The strategies they develop to make a living
3. The context within which a livelihood is developed
4. And those factors that make a livelihood more or less vulnerable to shocks and stresses

Livelihood assets:

Assets may be tangible, such as food stores and cash savings, as well as trees, land, livestock, tools, and other resources. Assets may also be intangible such as claims one can make for food,

work, and assistance as well as access to materials, information, education, health services and employment opportunities.

Another way of understanding the assets, or capitals, that people draw upon to make a living is to categorize them into the following five groups: human, social, natural, physical, financial, and political capitals

Human capital: the skills, knowledge, ability to labour and good health and physical capability important for successful pursuit of different livelihood strategies.

Natural capital: the natural resource stocks (soil, water air, genetic resource etc.) and environmental services (hydrological cycle, pollution sinks etc.) from which resource flows and services useful for livelihoods are derived.

Physical capital: this refers basically to the built environment which comprises the stock of plant, equipment, infrastructure, and other productive resources owned by individuals, the business sector, or the country itself that enable people to pursue their livelihoods.

Social capital: the social resources (networks, membership of groups, relationship of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods.

Financial capital: the financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) which provide them with different livelihood options.

Livelihood is more than just a man-to-land relationship, which was a major focus in the older livelihood literature. It is rather a holistic, causally interlinked and permanent process which is embedded in a larger social, economic and physical landscape and ends up with the aim of income earning or making a living. Bebbington (1999) defined livelihood as a process that encompasses income, both cash and in kind, as well as the social institutions, gender relations,

and property rights required to support and to sustain a given standard of living. A livelihood also includes access to and the benefits derived from social and public services provided by the state, such as education, health services, roads, water supplies and so on.

2.2.1 Sustainable Rural Livelihoods

Humanity has the ability to make development sustainable that is to ensure that it meets the needs of the present without comprising the ability of future generations to meet their own needs. It must go hand in hand with improved lifestyles for the least fortunate. Ellis (2000) postulates that livelihoods comprise of assets, activities and access to these that together determine the living gained by households or individuals. Rural people move regularly between rural areas and towns or cities to seek work, market their produce and buy manufactured goods. Rural families through livelihood diversification construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standard of living of which small scale irrigation schemes is one of the options. The sustainable livelihoods framework is designed to help understand and analyze poor people's livelihoods. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future while not condemning the natural resource base.

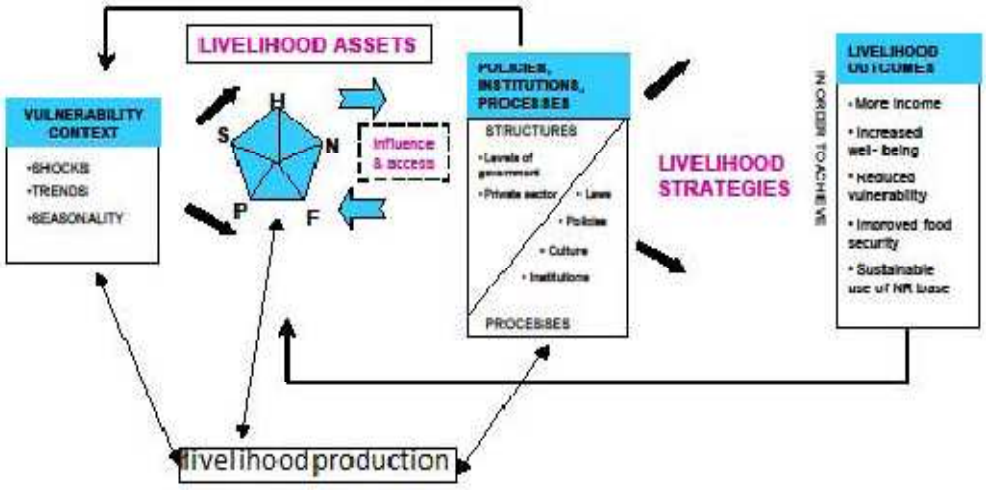


Figure 2.1: Sustainable Livelihood Framework

Source: Ellis, 2000

For sustainable livelihoods to be achieved the future of irrigation farming in alleviating rural poverty lies not only in people but calls for intervention of interested stakeholders in rural development. Irrigation farming is possibly one of the key drivers to enhancing rural livelihoods if necessary support is given to it. Chambers (1983) points out that participation should not refer to mere involvement but should mean that beneficiaries of development initiatives actively take part at all levels of development projects.

2.2.2 Irrigation development and Livelihood

a) **The linkages**

In development policy circles, irrigation was seen as ‘a privileged solution’ (Moris 1987).

Yet the success of the many irrigation development efforts initiated by governments and donors has been disappointing.

In spite of huge investments, productivity remains far below expectations. In addition to the criticism of not attaining anticipated increases in production, studies have also been critical of the tendency for irrigation development efforts to be accompanied by an increased differentiation between rich and poor. Irrigation projects tend to favor some farmers and households at the expense of others (Patnaik, U., 1990) irrigation often involves a switch to mono cropping, and because this requires expensive inputs it created difficulties for households without access to capital or credit. Increased dependency on money and markets for buying inputs and selling produce also tends to increase the vulnerability of large groups of farm households to livelihood insecurities (Patnaik, U., 1990). The Kenyan experience of the Mwea irrigation settlement project, for instance, resulted in farmers not being able to generate sufficient income to sustain their families, due to the high cost of, in particular, fertilizers and other agro-chemicals (Alukonya S., 1993). Whether and to what extent people were able to benefit from new irrigation opportunities depended very much on their ability correctly to apply water, purchases and required sets of inputs, and to follow prescribed cultivation techniques.

There is no doubt that irrigation has a central place as an engine for rural economic growth and as a means to ensure food security. Lankford (2003) on his study on irrigation development in Tanzania identified three stages in the perspective of livelihoods based irrigation development: proto-irrigation, irrigation momentum and river basin management. According to him in the proto-irrigation stage farmers are dependent on other livelihood activities than based on irrigated agriculture. But as the irrigation development gains momentum, farmers start moving to irrigated agriculture as main source of livelihood. In

the final stage, there is wide sc ale increase in irrigation activities leading to water scarcity not only for agriculture but also for other sectors expressing growing water needs. This stage re quires the need for sanctions, water management and conflict management. In response to the problems identified in the last stage role of end users in irrigation water management can be an important aspect.

Hasnip (2001) identified four inter-related mechanisms through which irrigated agriculture can reduce poverty or in other words improve livelihoods. Important in respect of this study are a) improvements in the productivity, incomes, employment for irrigators' households and farm labor; and b) the linkage & multiplier effects of agricultural intensification for the wider economy. Hussain (2007) in his study on exploring link between irrigation and poverty alleviation in six Asian countries found that poverty outside of irrigation systems (non-irrigated settings) is almost twice than that within irrigation systems. However badly designed and managed irrigation systems can have a significant impacts on the rural livelihoods. Some of these may include: a) unreliable supply of water to farmers leading to crop loss and diminishing returns (DFID 1997), and b) inequitable distribution of water on account of sediment deposition and growth of weeds in the main channels which may force farmers especially at the tail end of the system to opt out of irrigated agriculture (DFID 1997). Considering these ill-effects better operated and maintained irrigation systems especially with emphasis on end user managed systems becomes important.

Robert Chambers, a pioneer of livelihoods approaches, argued that the generation and support o livelihoods have a higher priority than production *per se* (Chambers 1988). He emphasized that the impact of irrigation on the rural poor depends on who produces the food and who has the ability to obtain it, on who gains and who loses more generally. Overall, he argued that the poor

gain from irrigation through increased employment and income, in improved security against impoverishment, from less out-migration and in improved quality of life.

In irrigated agriculture there are four inter-related mechanisms which have the potential to enhance and sustain rural livelihoods. These include:

i) Improvements in the levels and security of productivity, employment and incomes for irrigating farm households and farm labour;

ii) The linkage and multiplier effects of irrigation development (as part of wider agricultural growth) for the wider economy;

iii) increased opportunities for rural livelihood diversification;

iv) multiple uses of water supplied by irrigation infrastructure.

According to Burrow (1987), small holder irrigated horticulture had proven to be a viable and attractive option for poor farmers in developing countries. He further asserted that returns from intensive irrigated horticulture even on tiny plots could greatly exceed returns from rain fed cereal production. In many developing countries, small scale irrigation schemes were counted on to increase production, reduce unpredictable rainfall and provide food security and employment to poor farmers. Irrigation farming contributes significantly at the household in terms of income in rural areas. Having most of the rural household unemployed, most families' income levels are relatively low and possibly not enough to acquire basic commodities and services.

According to Moll (2004), a comparison of income earned from small scale irrigation and that earned from dryland farming or from non-skilled work in Zimbabwe industries revealed that small scale irrigation farmers earned more. In comparative analysis between irrigators at Nyanyadzi irrigation scheme in Zimbabwe and their dry land counterparts, irrigators' investment was estimated to be between $150 and $200 while dry land farmers' investment was estimated to

be lower than $100. This indicated that irrigators were in a better position to invest in capital items than non-irrigators because of higher incomes. Irrigation developments have made it possible for other rural infrastructure to be developed in areas which could otherwise have remained without roads, telephones, schools and clinics. According to Chenje et.al (1998) in the study of irrigation schemes in Chakuda Village in Gambia, small irrigation schemes have resulted in increased income that was translated into increased expenditure, investment, construction and trade. At the village level, increased material wealth manifested in the form of construction of a large mosque built through farmers' donations and an improvement of the village clinic. At household level increased wealth could be seen in fifty-five houses built in the village and fourteen with corrugated metal roofing.

Irrigation schemes often function as a development 'pole' in rural areas, where increased output and population concentrations attract additional services and infrastructure. Irrigated agriculture contributes to increased incomes from production and employment, so that families can gain access to schooling, health and welfare services, which are more likely to be present.

Irrigation brings a range of benefits to individuals and households that economists sometimes distinguish between *primary* and *spill-over* effects (Shah, 1993).

Primary effects

- Increased and more stable flow of income from farming made possible by increased intensity of cropping, improved yields and new farm enterprise / technology mixes.
- Appreciation of the value of land with access to water for irrigation.

Spill-over effects

- Increased and more evenly spread farm labour opportunities and improved wage rates.
- Reduced out-migration and increased return migration.

- Improved security against impoverishment.
- Lower food prices and better nutrition throughout the year.
- Growth in non-farm employment.
- Greater urban-rural contact and new social networks.
- More water for non-agricultural uses, including domestic uses that improve health.

All rural households, and particularly those who are net purchasers of staple foods, will also benefit from lower food prices and potentially better nutrition throughout the year.

Scoones (1996) states that, in semi-arid areas there is potentially no better way to reduce rural vulnerability and ensure the viability of people's livelihoods, than to enhance natural capital and the productive base. Protecting the system against drought requires investment in water management, and it is irrigation and the water storage provided by small dams or enhanced recharge of aquifers that can reduce the vulnerability of rural communities to periods of drought.

b) Livelihood diversification among irrigation households

Ellis (2000) identifies six determinants of diversification: seasonality, risk, labour markets, credit markets, asset strategies and coping strategies. One dimension of a sustainable livelihood is adequate and stable flows of income and consumption the whole year round. Seasonality is known to cause troughs and peaks in labour utilization, and can lead to food insecurity, due to the mismatch between uneven farm income streams and continuous consumption requirements. These are often called the 'labour smoothing' and 'consumption smoothing' problem, respectively. Diversification can contribute to reducing the adverse effects by utilising labour and generating alternative sources of income during off-peak periods.

Livelihood diversification reduces the risk of losing all income sources simultaneously, for example in an emergency (Ellis 2000), (Start 2001). It also implies trading a higher but more

risky income for a lower diversified and less variable income. However, this may not apply if households can exploit complementarities between their asset endowment and varying demand and returns in product and labour markets. Labour markets may offer opportunities to achieve higher returns to labour or prompt diversification because of the discontinuity of casual employment (Ellis 2000).

Cash resources obtained from diversification may be used to invest in, or improve the quality of, any or all of the five forms of livelihood assets. They may be critical when access to credit is limited, for example, sending children to secondary school or buying equipment, such as an irrigation pumpset, that can be used to enhance future income-generating opportunities. It is also possible for diversification to improve the independent income-generating capabilities of women. By achieving this it also improves the care and nutritional status of children, since a high proportion of cash income in the hands of women tends to be spent on family welfare.

Livelihood portfolios of most rural households comprise a number of livelihood strategies with some being more predominant than others (Ellis, 2000). Some households may have primarily irrigation-based livelihoods (Lankford, 2003) whereby more than half of their livelihood base rests on irrigation, while other households may access more than half of their income from a range of livelihood activities. The former scenario can be termed as ‘specialization within diversification’. Specialization within diversification phenomenon dominated the previous livelihood policy thinking, which was tendered on the assumption that rural people always chose a particular livelihood strategy among available livelihood options and choices.

However, there has been growing recognition of livelihood diversification as an option in itself and not always a process of screening for a better option or a response to crisis. Thus, households sometimes enter into diversification as a matter of choice (for example, as a coping strategy for

rural poor and means of accumulating wealth for rural rich) and not always out of necessity (Ellis and Freeman, 2004). Various approaches have been devised which aid in explaining activity profiles -and hence livelihood strategies- for rural households. One commonly used approach is the income portfolios approach, which captures activity profiles by analyzing income portfolios across households (Ellis Mdoe, 2003). This paper observed that the extent to which a community's livelihoods system is dependent on a certain livelihood activity is reflected in the level of income derived from that activity, and the impact of its absence in some livelihoods within the system. In support of this observation Ellis (2000) asserted that livelihood and income are related and individual or household income is the most direct and measurable outcome of the livelihood process.

c) Livelihood adaptation and irrigation

Livelihood adaptation can be described as a process of 'changes of livelihoods, which either enhance existing security and wealth or try to reduce vulnerability or poverty' (Davies and Hossain 1997:5). Besides, the adaptive capacity of a household also has to comprise the important element of enhancing abilities in order to address future risks (Eakin 2005). For that reason, adaptation is a response to a rather long-term process in contrast to coping strategies, which refer to short-term livelihood reactions in the consequence of unplanned or unforeseen crises following events like droughts or floods. A typical sequence of response to such unforeseen events would be the rapid establishment and diversification of new income sources, the utilization of reciprocal social capital bonds, the reducing of the current household size (e.g. via temporary migration), the sale of movable assets like livestock and last the sale of fixed goods like farm land or other realties. This sequence implies that farm households naturally first

of all struggle for maintaining their future income by generating assets before selling assets which are essential for their future survival (Ellis 2000:44).

One key role for adaptation and the reduction of such vulnerabilities holds according to Ellis (2000:14-15) the diversification of livelihoods. The diversification of rural livelihoods is defined as 'the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standard of living' (Ellis 2000:15). The increase of a livelihood portfolio, in other words: the attempt to multiply the sources of income like off-farm labour, remittances from migration stays, etc., might be an outcome of a livelihood adaptation process, but diversification is not necessarily the only way of adaptation. Intensification, which is referring to existing income sources that are used more intensively to guarantee a higher income, is another option. According to Agrawal (2008:19), besides diversification and intensification, other instruments for livelihood adaptation - especially under the conditions of climate change and increasing climate variability - can be the storage of perishable food stocks and water. Furthermore, adaptive capacities can be strengthened with instruments clearly exceeding the borders of a sole rural household. Such measures would be the pooling of joint communal resources and activities, such as the sharing of labour, income from different sources or wealth among different households. But also (an increased) market exchange or a higher market orientation can be seen as a crucial instrument for adaptation in rural poor households. Additionally, an increased reliance on the factor mobility - from a dislocation of livestock and the seasonal migration of one or more household members to the point of a complete and enduring dislocation of a whole household - is an option in this context. All adaptive measures mentioned are of course not pure ideal types. Taken from real life experiences, livelihood adaptation instruments are nearly always a mixture of the different types

named above. All these measures maintain, optimize, modify, rearrange the composition of livelihood strategies or change the geographical setting of the livelihood strategies a household relies on.

Even the adaptation instruments themselves can to a large degree be a livelihood strategy; thus, livelihood adaptation and livelihood strategies are generating a close nexus.

Choice of livelihood strategies is dependent upon a number of factors including capabilities one has such as social networks, skills and physical assets (Ellis, 2000). In his analysis of stages of irrigation development, Lankford (2003) identified factors that affect access to irrigation-based livelihoods, based on livelihood framework. He argued that natural and physical factors such as water, land and labour, and economic and financial factors such as market prices, inputs and credits, human and social factors such as social cohesion and conflict resolution, other livelihood strategies (diversified livelihoods), and skills and experience in irrigation and negotiation, all play a role in determining and developing household's livelihood strategy.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1 The Study Area

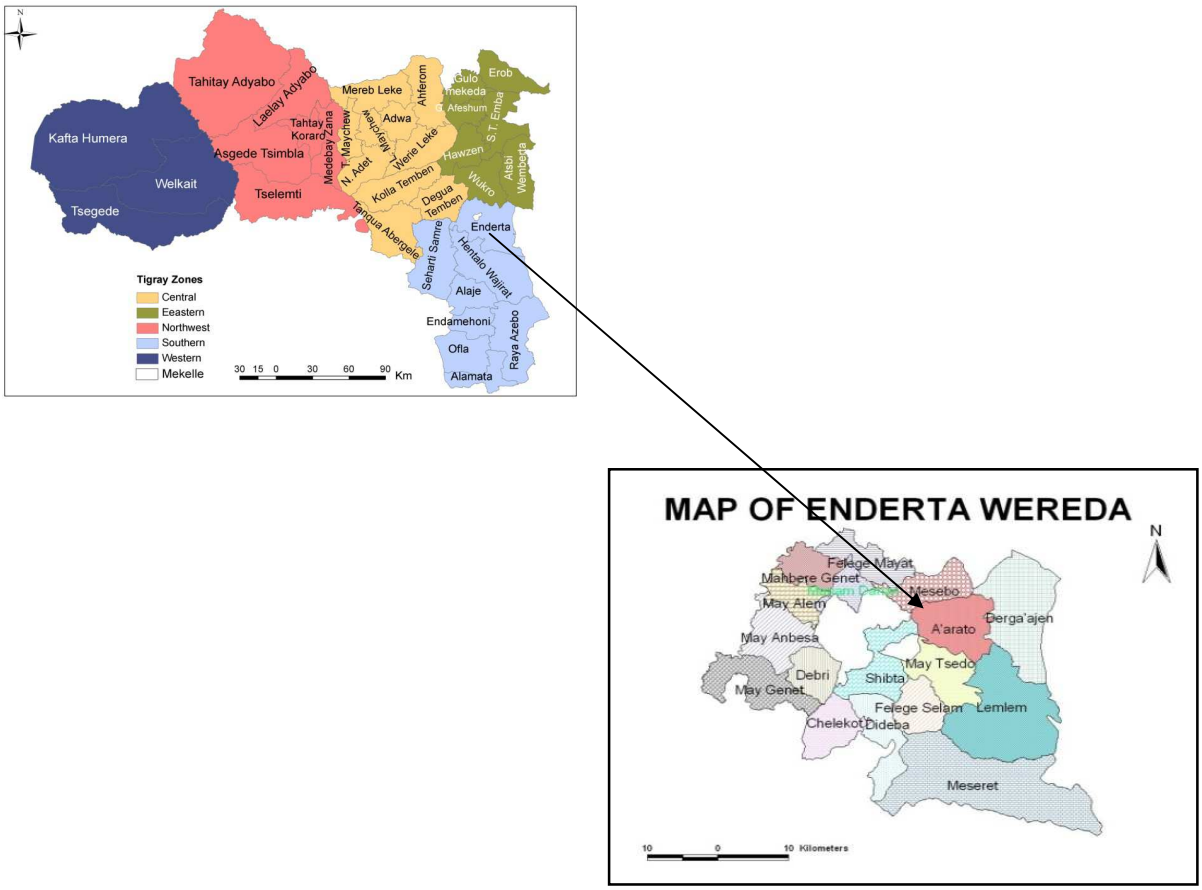
Enderta is a district found in south eastern Administrative Zone, Tigray Regional State, Ethiopia. It is located 785 km North of Addis Ababa, capital city of the country, and geographically laid on 13º 15' 00" to 13º 38' 30" North Latitude and 39º 17' 30" to 39º 48' 30" Eastern Longitude. It is bordered with Dogua Temben and Seharti-samre districts to the West, with Afar regional state to the East, with Kilte Awlaelo district to the north and with Hintalo Wajerat district to the south. (EBoARD, 2012) It encompasses 17 PAs and 69 villages with a population of 114277 of which 57472 men and 56805 women (CSA, 2007). All of the population belongs to the Tigrigna speaking people. The dominant religion is Orthodox with very few Islamic followers (CSA, 2007). The district is characterized by flat to undulating topography with altitude of ranging from 1500-2300 m.a.s.l. It is also characterized uni-modal (one conventional rainy season which occurs from June to end of August and varies from 350-750mm per annum and the minimum and maximum temperature is 20 ^{0}c and 26 ^{0}c respectively.

3.1.1 Livelihood Zone of Enderta

The district is at the dry midland livelihood zone of Ethiopia. This livelihood zone lies in a drought prone area exacerbated by infertile soils and suffers from chronic food shortages. The main food crops cultivated are barley, wheat, teff and lentils. The middle and better-off households produce most of their own food. The poorest household cultivates small areas of land as they do not have plough oxen and so purchase most of their food. Livestock provide the main

source of income for the middle and better-off households. The incomes of the poor and the very poor come from a range of activities: PSNP, firewood sales and labour sales. Access to market is good.

Map of Tigray Region



Map 4.1: Location map of the study area

Source: *Agriculture and Rural Development Disaster Management & Food Security Sector, 2009*

3.1.2 Climate

According to the Enderta district Agricultural and Rural Development Annual Report 2012 the district has a combination of three agro-climatic zones, namely 1% High land, 96% Midland and

3% lowland. The study areas lie in the midland agro ecology, characterized by dry climatic conditions and erratic annual rainfall of 450-550mm. And the mean monthly temperature is around 18 ^{0}C.

3.1.3 Topography

According to the 2012 Enderta district Agriculture and Rural Development Annual Report the topography of the area of the district comprises, 35% plain land, 40% gentle slopping, 10% undulating and rugged terrain and, 15% steep mountains.

The topographic features are from flatter to steeper slopes due to the presence of depression and ridges. The terrain is mostly plains and hills, with bush scrub vegetation. The land is rocky with limestone and marble resources.

3.1.4 Farming system

The district has a total area of 140,000 hectares. Out of this 32,490.525 hectares are cultivated land, 28,543.225 hectares grazing land, 23,314.5 hectares forest and bush land, and the rest 55,651.75 hectares are uncultivated land and waste land (EARDO, 2012).

Agriculture is based on rain-fed subsistence mixed farming system and traditional oxen driven implements type, where the major crops grown are wheat, barley, teff, and minor crops such as beans, chickpeas, lentils and flax. Animal population comprising about 48129 cattle, 22638 goats and sheep, 9618 equines, 309 camels and 350243 poultry, (EARDO, 2012). The vegetation cover of the study area has been disturbed because of encroaching and illegal destruction either for domestic use like farm implements, fuel wood, or invading of marginal farm lands. This destruction of vegetation has in turn created an aggressive run off by eroding top soil loss and

failure of soil fertility. Major live stock production constraints are shortage of animal feed and killing disease such as pastoralists, blackleg, anthrax, foot and mouth disease and internal and external parasites.

3.1.5 Population and socio economic features

Based on the Enderta BoARD office report, 2012, the district has a population number of 144,227 and 26,600 households and a population density of 93.8 persons per km square.

Arato is a peasant association that has 10,222 populations and 2837 households. Shiguala and Mielate are the two villages selected for study from this peasant association. Mielate is the village with irrigation access, where as Shiguala is not. The main livelihood activities carried out in the study area are crop production and animal husbandry. Since the PA is around 30km from the capital city of Mekelle, the capital city of the region, most of the households participate in off farm and nonfarm activities like building construction and supply of stone quarry and other construction material preparation. There are also some supportive activities like food for work in governmental and non-governmental organizations.

Semha diversion is found in specific site called Semha, Arato peasant association, constructed by Relief Society of Tigray (REST) in 2007.

3.1.6 Irrigation and water source potential

Based on the Enderta water resource office report (2012) the main water resources of the district are perennial streams, wells, rain water harvesting ponds etc. In the district there are nine micro dams, 14 river diversion, 18 water harvesting check dams, three communal reservoirs, 56 communal and 12 private open irrigation wells. According to Enderta wereda bureau of

agriculture report (2012) the irrigation area of the district is 7696 ha that have 12881 household beneficiaries. Semha diversion was constructed in 2004 G.C with the discharge capacity that can irrigate above 80 hectares of land. The scheme is irrigating 48 ha of land for 281 beneficiaries.

CHAPTER FOUR

RESEARCH METHODOLGY

4.1 Data Collection and Analysis

4.1.1 Sources of data

Both Primary and secondary data sources were used. Primary data is collected directly from respondents using questionnaires and interviews. Secondary data is collected through review of related published and unpublished literatures.

4.1.2 Sample size and sampling procedure

Semha irrigation scheme was selected purposely because of its proximity for time and budget constraint; its capacity that covers wider command area and more beneficiaries.

The people's livelihood of the study area is dependent on irrigated and/or rain fed agriculture. Some of them have land in both rain fed and irrigated while others have only rain fed agriculture. Thus, both access with irrigation and without access to irrigation are target populations. The number of households of Mielate villege is 281 and 160 of them are irrigation users from the diversion, where as in Shiguala the 310 households have no access to use irrigation. With regard to the sample size the researcher believes that more sample households could have better representative of the whole population. However, to make the research more manageable a total of 120 sample households, that comprises 60 from irrigation users of Mielate village and 60 households of the adjacent non irrigation users from Shiguala village through lottery sampling method were sampled as shown on table 4.1 below.

Table 4.1 Sample size of respondents and their proportion to the respective households

Sample households	Irrigation users		Non irrigation users		Total	
	Sample	%	Sample	%		
Sample size	60	21	60	20	120	20
Sample population	275	20	294	19	569	19

4.1.3 Data collection method

Primary data were collected using a structured questionnaire from household survey. The household survey was the main method used to collect quantitative information. A carefully designed questionnaire consisting of interrelated questions was employed and administered by semi-trained enumerators.

The primary data collected from the households were also further strengthened by additional information which was gathered from focus group discussion using checklists. Individuals who were considered knowledgeable and rich in experiences about irrigation activities and socio-economic condition of the community in the study area were also interviewed individually in addition to personal observation.

Secondary data was collected from published literatures and unpublished reports from the district and peasant association offices.

4.2 Data processing and Analysis

After the field work has been completed, data entry and processing (editing and coding), omissions, legibility and consistency of the data were checked to correct errors during data collection. The collected data through households' questionnaire entered to the Statistical

Package for Social Scientists (SPSS) version 19. Quantitative data analyses were carried out using the descriptive statistical tools such as percentage, maximum-minimum, and mean. The statistical significance of the variables in the descriptive part were tested for both irrigation user and non irrigation users using t-test.

Qualitative data collected through interviews, focus group discussions and observations were put into different categorical variables. Major themes were identified and analyzed in line with research questions and were summarized for use in descriptive analysis.

Identified themes of the qualitative survey were exposed to categorical arrangements of the quantitative survey outputs. Issues intended to be addressed by the research are analyzed using findings from both quantitative and qualitative surveys.

CHAPTER FIVE

RESULT AND DISCUSSION

5.1 Demographic Characteristics of sample households

In rural Ethiopia, family size, age and sex of the family head are important demographic features affecting the livelihood security of a household. Therefore, family size and compositions of the sample households were used to characterize the respondents. The number of family size has a strong relation with other household resource endowments. Based on the key informant interview the family size has direct relation to land holding size and income of the family.

Table: 5.1 Demographic characteristics of sample respondents

Respondents	Irrigation user		Non irrigation user		Total
	No.	%	No	%	No
Population	275	-	294	-	569
Sample HHs	60	-	60	-	120
Male	54	90	51	85	105
Female	6	10	9	15	15
Age of HH heads					
25-64	48	80	53	88	101
>64	12	20	7	12	19
Family size	4.6		4.9		
Family Age group					
<15	67	24	91	31	158
15-64	135	49	157	53	292
>64	73	27	46	16	119
Dependency ratio	140	51	137	47	277

As shown in table 5.1 the sampled households were 120 that consist 60 from the irrigation user and 60 from the non irrigation user households of Mielate and Shiguala villages. The total population size of the sampled households is 569 that comprise 275 of irrigation users and 294 of non irrigation users of the sampled households.

In the study area, the head of the household generally is responsible for the co-ordination of the household activities. As such it is pertinent to examine attributes such as sex and education of the head as one component of irrigation participation decisions. The researcher has observed the age of the household head influences whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. The 80% of the irrigation user and 88% of the non irrigation user of the respondents laid between 25-64 age group which is potential labour force for their household and the remaining 20% of irrigation user and 12% of the non irrigation user are above 64 age group.

It is also found that an extension system provides equal chance of participation in the economy and equal access to productive resources. The table shows, of the 120 sampled households, 90% of the irrigation user and 85% of the non irrigation user are male headed while the remaining 10% and of the irrigation user and 15% of the non irrigation user are female headed households.

5.2 Human capital

Human capital represents the skills, knowledge, and labour availability and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. Labour availability and access to education of the sampled households are taken as indicators of human capital in this study.

5.2.1 Household composition and Labour availability

Household family is the main source of labor for all income sources in Rural Ethiopia. Family labour in traditional agriculture is the most important factor of production both for increasing income and production and hence improving livelihood. As stated in FAO (2010), family size in adult equivalents indicates the sample households' average family labor force for agricultural production and other income-generating activities.

Based on table 5.1, the active labor force (15-64 years) of the total population is 49% for irrigation user and 53% for non irrigation user households. This shows there is no significance difference of labour availability between irrigation user and non irrigation user households.

The dependency ratio shows the ratio of economically inactive compared to economically active. Economically active members of a household, whose age is from 15 to 64, are assumed to be the principal sources of income for the household. Household members under 15 and over 64 are assumed to be economically inactive and dependent on economically active members of a household for education, clothing and health care. The dependency ratio of agricultural households provides planners and policy makers with an indication of agricultural labor availability in male- and female-managed holdings and their abilities to actively participate in agricultural programs and projects. Members of holdings with high dependency ratios might not be able to participate in programs and projects due to time, labor and/or financial constraints, that is, dependency ratio is thought to be negatively related to income of households (FAO 2010). Based on the study, dependency ratio of the irrigation user households is 51% and 47% for non irrigation user households. Economically active persons had the responsibility to feed, cloth, educate and medicate the extra dependent persons. Economically active (49%) members of the irrigation user households are less than non active members, whereas active members (53%) of

the non irrigation user households are more than the non active members. This can have important implications for livelihood improvement efforts.

Based on the survey result, the average family size of the sample households are 4.6 for irrigation user and 4.9 for the non irrigation user households. However in rural economy, children labor is mostly used for cattle rearing and in some areas children with in the same age group participate in agricultural activities, especially in weeding and threshing. As shown in table 5.1, there is no wide variation in the family size and labor availability between irrigation user and non-irrigation user households. Compared to small average farmland shortage of labor could not be a serious problem at a household level. However, since irrigation is a labor-intensive agricultural practice, labor demand for irrigation user households is expected to be higher than that of rain fed households.

In the study area the labor force has a strong relation with the household level of off-farm and nonfarm income and agricultural productivity. The survey result revealed that most of the households who have participated on daily labor, petty trade and out migration activities have a larger family size.

5.2.2 Access to Education

Economic growth is driven by change in people's capabilities or their human capital, as affected particularly by their education. As to Ethiopia strategy education is one of the achievements in Millennium Development Goals of the government that had been focused. Based on this many rural areas have been benefited from new schools, more teachers and increased enrolment rates in the past few years.

Based on the focus group discussion, the number of schools and/or teachers is with the same access for both the irrigation user and non irrigation user households. The main issue is sending

of children to school based on the set criteria which is directly related on the household heads interest, economy, awareness and other related factors. Hence the study tries to assess the household ability to send his/her children to school.

Table 5.2 Education status of the respondents' children

Sample households; children	Irrigation user		Non irrigation user		Total
	No.	%	No.	%	
Total no of children above 7 years old	91		105		348
Access to education					
None	28	31	29	28	57
School	60	66	72	68	132
College	3	3	4	4	7

Based on the table 5.2, 66% of the irrigation user and 68% of the non irrigation user farm household respondents' children attend school now. Irrigation user households are expected to have more money than they used to, as a direct consequence of increased crop surpluses; and/or the effects of education and training leading to increased awareness of the importance of education. However there is no significant difference between irrigation user and non irrigation user in sending of children to school.

In the study area majority of the parents are increasingly willing to invest more in educating their children.

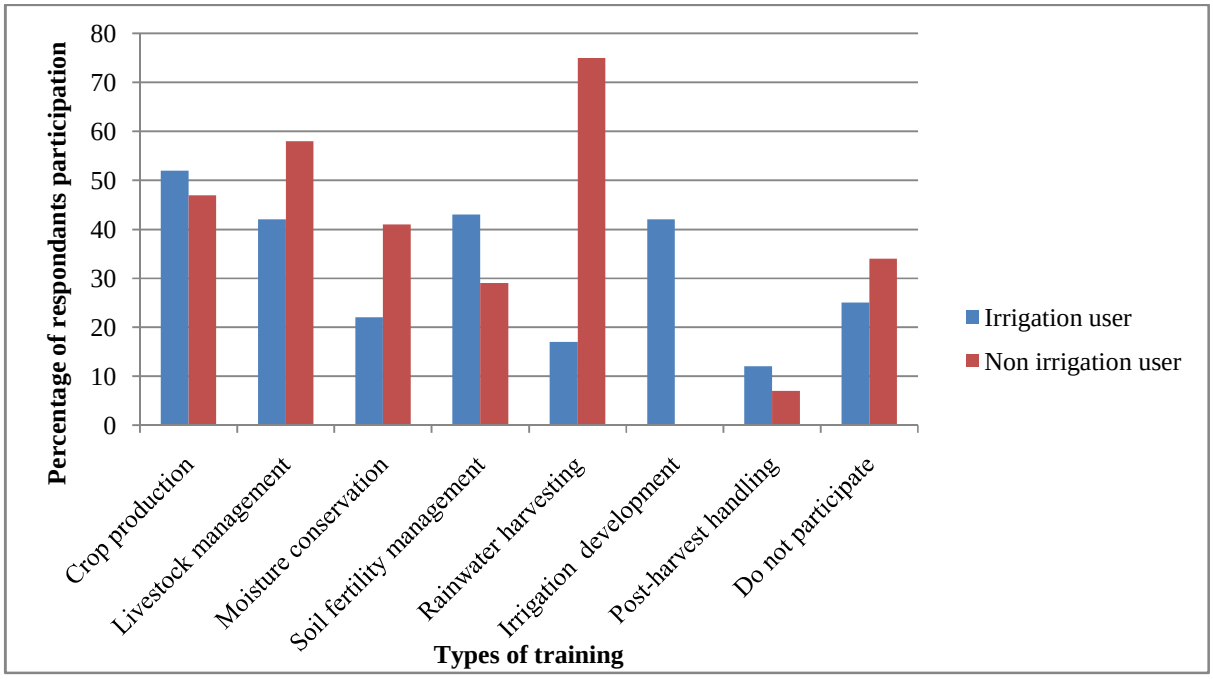
As a consequence of the increasing trend to educate children on both of the villages and in general the district, some have started now attending further education (college/university) elsewhere. Of the sample households 3% of the irrigation user and 4% of the non irrigation user

households' boys and girls has joined universities. These children are not expected to return to their family works, but to look for employment opportunities elsewhere in the country. To the extent that out-migration of educated children in this way will reduce farm household labour availability.

5.2.3 Training and knowledge transfer

Agricultural training including on crop production and livestock management is crucial for rural mixed farming farmers to improve their productivity in sustainable way. Besides sharing of experiences and knowledge transfer from farmer to farmers and from experts to farmer is becoming the reliable way of extension in agricultural development like irrigation.

Figure 5.1: Type of training the sample households participated in percentage



As shown in the figure 5.1 some of the farmers were participated on different types of training. The main training types were crop production, livestock management, irrigation development for the beneficiaries and others. All of the trainings were given at their central site (farmers training center) and some at district level. Most of the trainings given at class level theoretically without

any practical practice and the participants were repeated at most of the trainings. The training was given based on the gap they have and assessing the problem of the farmers they face. It was observed that there were no differences in irrigation management practices at the irrigation area in households of the trained and from non- trained once.

Table 5.3: Participants' satisfaction on the overall training given

Determinants	Irrigation user		Non irrigation user		Total	
	No.	%	No.	%	No.	%
useful	14	33	13	35	27	34
Less useful	19	45	17	46	36	46
useless	9	21	7	19	16	20
Total	42	100	37	100	79	100

The table 5.3 shows the training participants satisfaction on the given different trainings. Of the training participated 33% of the irrigation user and 35% of non irrigation user households were expressed as very useful and 45% of irrigation user and 46% of the non irrigation user households as that can contribute little to their knowledge and experience. However the 20% of the trained households were not satisfied with the trainings they got.

Based on the focus group discussion the visit of the extension workers is mainly for campaign works like community mobilization for soil and water conservation, fertilizer provision and irrigation development at community level. In addition to the less frequent visit the transfer of knowledge through community/group meeting is less effective in comparing with individual/household level visit of farming activities.

Figure 5.2. The frequency that DAs visited the farming activities of the households

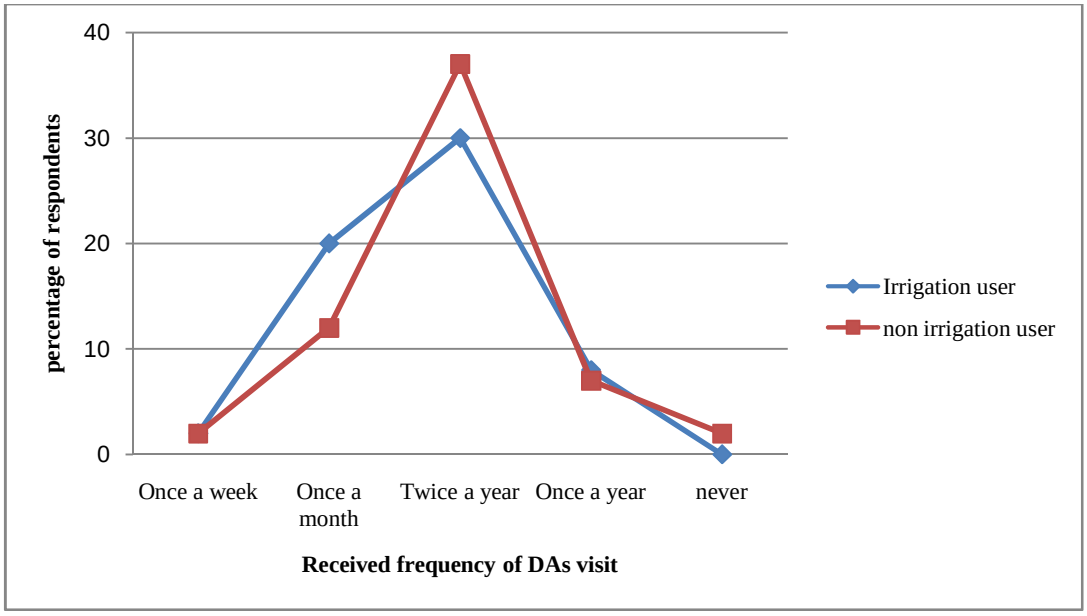


Figure 5.2 indicates there is no variation in the frequency of agricultural development visits between the irrigation user and non irrigation user households. Both of the farm households are visited mainly (35%) by development agents twice a year mostly at the beginning and end of the rainy season. Moreover majority (17%) of farmers recall seeing once in a month for various extension works as general. But there are also farmers (4%) that didn't either know whether DAs ever visits or confirm that this never happens. The household survey indicates that there is no significant difference between the irrigation user and non irrigation user households in access to agricultural knowledge transfer through visited by DAs. However since irrigation is undertaken throughout the year and needs close follow up it is expected to be visited frequently by concerned experts and extension workers. In order to maximize the benefit from irrigation frequent visit and follow up is crucial but it is not in the study area.

5.3 Natural capital

5.3.1 Land holding

Farming provides the primary source of livelihood for the majority of households' of the rural areas of the country. Land is the major productive asset in agrarian countries like Ethiopia. Cultivated land appears to be the most important scarce factor of production.

As stated in Underhill (1990) direct impacts of land include an increase agricultural productivity levels as a result of large size and fallow system since there is option for leaving some of the land without sowing for one or more seasons. Where as in irrigation agriculture the impact is more than rain fed areas. The increase in cultivable land increase agricultural productivity as a result of improved access to soil moisture, whereas negative impacts such as water logging and reduced soil fertility can be considered as contributing to a lowering of productivity levels in irrigation lands.

Interviews and group discussion revealed that households generally perceive the amount of land owned to be the main determinant and indicator of wealth, and this particularly applied to the amount of irrigated and / rain fed land owned.

The average land holding size of the sample households in the study area is 1.46ha. Thus the average land holding of the irrigation user household is 1.44ha and 1.49ha for irrigation user and non irrigation user households respectively. The irrigation beneficiaries have an average of 0.21ha of land at the irrigation command area. There is no significant difference between irrigation user and non irrigation user households in average land holding size. Thus, the overall land holding per household among the study group is similar. The difference is accessibility to irrigation that expected to have an impact on livelihood status variation.

5.3.2 Soil fertility

According to the information obtained from key informants land distribution was made based on the fertility status of the land and family size. For the purpose of fair distribution, available farmland was classified into three categories as fertile, average fertile and less fertile. Categorization of land to such fertility status was made through the joint consultation of the then land distribution committee and the community at large.

Water holding capacity of farm plots depend on the texture of the soil. Farm plots with fine soil particles have the ability to hold water and the soil pore could hinder the water movement. In contrast, courser soil texture creates percolation of water with higher seepage. Mainly for moisture conservation and nutrient availability organic matter content of the soil is consider to be the main factor. The organic content of soil differed based on the type of plants grown, frequency of cultivation, inputs used. Irrigation creates the option for second and third season production. Based on the informant interview, as a result of intensification of agricultural production, the quality and fertility soils of irrigable plots could be affected. Hence low soil fertility of the irrigable area is one of the factors that minimize its productivity in the study area.

According to the local soil fertility, respondents' classification 50% fertile, 32% medium and 18% poor for irrigation user households, whereas 65%, 28% and 7% is fertile, medium and poor for the non irrigation user households respectively. The study revealed that there is no significance difference between the irrigation user and non irrigation user lands on fertility status.

5.4 Financial capital

Financial “capital” consists of the financial resources that people use to achieve their livelihood objectives. The definition used here includes flows as well as stocks and it can contribute to consumption as well as production. There are three main forms of financial capital: savings in cash, bank deposits or liquid assets such as livestock and jewelry; loans obtained from formal or informal credit-providing institutions; and regular inflows of money including earned income, pensions, and remittances DFID (2002). The household gross income that includes income from cropping, livestock, off farm and nonfarm, and saving and credit access are the main indicators used in this study.

5.4.1 Household income

Rural communities of the study area are dependent on agriculture for their livelihood. Based on the group discussion crop production from irrigable and rain fed farm lands, animal and animal products and off-farm and nonfarm activities, are the main source of income.

Household gross income is derived from agricultural (crop and livestock) sales and value of crops and livestock products retained for household consumption. The value of retained crop and livestock products was calculated using annual average nominal prices. In the case of irrigation user households, individual household cropping income was computed from both rain fed and irrigated crops but for non irrigation user households, cropping income was derived from only rain fed crops. The off-farm and non-farm incomes were also computed as part of gross household income. Therefore considering all income sources are important to evaluate impact of irrigation on household gross income.

5.4.1.1 Income from crop

The most common crops grown in the rain fed area are barley, wheat, maize, teff, lentil, enguaya whereas in the irrigation area maize, wheat, carrot, onion, garlic, enguaya. These crops are grown as staple and cash crops in the study area. The estimation of crop income uses taking the mean annual average price for both the sold and home consumed crops.

Table 5.4: Major crop types and their mean annual production values in 2012/2013

Major crops	Average annual price (ETB/100kg)	Irrigation user		Non irrigation user		t-value for difference in production value
		Production value in 000ETB	% of total income	Production value in 000ETB	% of total income	
Maize	600	1.9	16	1.2	15	1.3
Teff	1300	0.2	2	1.5	18	1.1
Wheat	700	1.7	15	2.1	26	1.7
Barely	650	0.7	6	2.3	28	0.5
Lentil	1100	1.4	12	0.5	6	2.1*
Carrot	1500	1.6	14	0	0	2.8**
Garlic	2100	1.5	13	0	0	2.6**
Potato	1200	0.6	5	0	0	1.2
Vetch	1000	1.5	13	0.6	7	0.8
Onion	800	0.6	5	0	0	1.9*
Total		**11.7**	**100**	**8.2**	100	3.2**

**,* indicates significant at 5% and 10% significance level respectively

As in table 5.4 shown the major income source crops for irrigation user households were maize (16%), wheat (15%) and carrot (14%) whereas for non irrigation user households were barley (28%), wheat (26%) and teff (18%). Barley, wheat, teff and maize are the main sources of income cereal crops on the irrigation and rain fed of the study area and only carrot contributes more from cash crops in the irrigation area. The mean income difference shows that irrigation

user households were better off in all cropping income than non irrigation user households except barley, wheat and teff. This suggests that small-scale irrigation development increases the incomes of rural household because irrigation directly influences the highest income source, cropping.

Total cropping income is the amount of mean annual income of a household obtained from both types of cropping systems, rain fed and irrigation. The mean annual income of a household from cropping income in the sample households is 11,700 ETB for irrigation user and 8,200 for non irrigation user household. This shows there is significant difference between irrigation user and non irrigation user households in crop income at 5% significance level in the study area.

Picture 5.1 *Carrot products harvesting from the irrigation area*

Input use

In the region in general, in the study area in particular the cultivable land had been over utilized for decades and the fertility of the soil is poor for crop production. Usage of improved seed, fertilizer as well as both manure and compost is becoming the only option for better crop production in rain fed and irrigation lands.

Based on the household survey 83% of the irrigation user and 80% of the non irrigation user households were used inorganic fertilizer (urea and/DAP) for their crop production in the year 2012/13. All of the sampled households have used farm yard manure where as 87% of the irrigation user and 58% of the non irrigation user households have used improved seeds. Those who did not use commercial fertilizer suggested that it was expensive and they couldn't afford. Thus, they preferred to use only farm yard manure. There is no significance difference between the irrigation user and non irrigation user households.

5.4.1.2 Income from Livestock

The type of agriculture in the study area is settled agriculture with a mixed farming system, integrated crop and livestock production. Livestock are the most important productive assets in the rural household. In the study area, livestock are important source of power for plough, thrashing, and transportation. They play role in religious and serve as source of prestige. It also considered as a saved asset used during periods of food shortage. The average livestock holding for sample households was 3.66 TLU. There is no significant difference between irrigation user (3.7) and non irrigation user households (3.62) in the average holding of livestock (Table 5.5).

Table 5.5: Average annual livestock income in ETB and Number of livestock (TLU)

Sample Households	Average income in ETB	Minimum	Maximum	Average number of livestock(TLU)
Irrigation user	2,230	0.0	4,580	3.7
Non irrigation user	2,090	0.0	5,320	3.62
Total	4,320	0.0	9,900	3.66
t-value for difference				0.06

Livestock play a significant role as income sources in rural poor Ethiopia. Based on the district report of 2011/12 Sale of live animals and their products are main livestock-related income sources in the study area. The livestock income category includes income from the sale of livestock, livestock products (i.e. milk, eggs, honey etc.) and other by-products like hide and skin. The values of sale and own consumption livestock and livestock products were estimated based on the average annual nominal prices.

The mean livestock income for irrigation user and non irrigation user household was ETB 2,230 and ETB 2,090, respectively. The average livestock income between the irrigation user and non irrigation user household is similar. The overall mean income of livestock and livestock products sale in the sample households is ETB 4,320 with a minimum of 0 and a maximum of 9,900. This indicates that livestock farming is one of the main income sources of the study area households. The income is mainly from live livestock sale, this shows the products like milk are for own use rather than for sale. This is due to low milk product from the existing breed and there is no market nearby to their village even for the available one.

5.4.1.3 Off-farm and nonfarm incomes

Off- farm and nonfarm are important parts of total income source for rural households (FAO, 2010). They are significant for purchasing power and food security. Since the study area is nearby to the

capital city of the region (*Mekelle*) there may be different opportunities of employment and off farm activities.

The study revealed that the main off-farm and nonfarm activities are community based cash/food for work, PSNP, stone quarry including cobblestone and aggregate preparation, mason works, guarding in the city and nearby projects. In addition employment on other farms during weeding and harvesting seasons, selling of fire wood and charcoal and petty trade were also some of the activities that contribute for to improve the income of some households.

Table 5.6: Type of off farm and nonfarm activities of the sample households

Type of off farm activity	Irrigation user		Non irrigation user		Total
	No	%	No	%	
Community based Cash/food for work	33	55	42	70	75
PSNP	46	77	51	85	97
Mason	13	22	37	62	50
Petty trade	17	28	24	40	41
Sale of fire wood	7	12	36	60	43
Stone quarry (stone, aggregate and cobblestone)	11	18	57	95	68
Guarding	14	23	41	68	55

As shown in table 5.6, most of the sampled households (97%) were participated in productive safety net program (PSNP). PSNP is country level program that focuses on food security through community mobilization on communal works especially natural resource management and with the main goal of household asset building. Food insecurity of a household is the main criteria to be selected for this program. Of the sampled households77% of the irrigation user and 85% of

the non irrigation user were included in the program. This shows most of the households of the study area are food in secured whether they are irrigation beneficiary or not. However as irrigation is an opportunity for better income from farm produce, it was expected the irrigation beneficiaries to be minimum or not in the PSNP program.

As shown in the same table, 95% of the non irrigation user households off farm activity were on stone quarry, and cobblestone and aggregate preparation where as 18% for the irrigating households. The study revealed that the non irrigation user households have access to such resources and employment opportunity throughout the year.

The study revealed that the average off-farm income for sample households was ETB 2,878. This is the non irrigation households have an average of ETB 4,475, whereas irrigation user households have an average income of ETB 3,200 from off farm activities. The difference in off-farm income between irrigation user and non irrigation user households is statistically significant at 5% level. This implies the non irrigation user households have a tradition of employing their labour in different off farm activities throughout the year except few months of farm work. In contrast the irrigating households do not appear to gain additional more income from casual laboring because their labour force always engaged on their irrigation land though it is not effective compared to the income gained from the irrigation product.

5.4.1.4 Summary of annual income sources at household level

The total mean annual household income of the sample households was ETB 14,988 (Table 5.7). From the total mean annual income of a household, cropping contributes the highest income share (66%) followed by off-farm and nonfarm (19%) and livestock (14%), respectively. It provides some indication of the extent to which income sources for the farm household as a

whole are diversified. Incomes from these sources were very variable and thus the mean figures given are purely indicative.

Table 5.7: Summary of annual household income sources

Characteristics	Irrigation user		Non-irrigation user		Total		t-value for difference
	ETB	%	ETB	%	ETB	%	
Crop income	11700	77	8200	56	9950	66	3.2**
Livestock income	2230	15	2090	14	2160	14	0.6
Off-farm and non farm income	1280	8	4475	30	2878	19	-1.9**
Total income	15210	100	14765	100	14988	100	**0.7**

Table 5.7 summarizes the income earned in aggregate from cropping, livestock and off farm activities. Irrigation user households earn higher income from cropping than non irrigation user households. On the other hand non irrigation user households have earned higher income from off farm and nonfarm activities than the irrigation user households. However, there is no significant difference between irrigation user and non irrigation user households in their livestock incomes. The main sources of income for the irrigation user households are 77% cropping, 15%livestock and 8% off farm activities. Whereas for non irrigation user households cropping 56%, off farm and nonfarm 30% and livestock 14% comprises their income source.

Hence based on the study survey from the sample households, there is no significance difference in total household income between the irrigation user and non irrigation user households.

Comparison of the total income of irrigation and non irrigation user households may thus provide some evidence that low contribution of irrigated farming and growing contribution of off farm income to total household income, and livelihood in the study area.

5.4.2 Credit and savings

Most poor people manage to mobilize resources to develop their enterprises and their dwelling slowly over time. Financial services could enable the poor to leverage their initiative, accelerating the process of building incomes, assets and economic security. However, conventional finance institutions seldom lend down-market to serve the needs of low-income families and women-headed households. They are very often denied access to credit for any purpose, making the discussion of the level of interest rate and other terms of finance irrelevant. Meddison, (1970)

Credit is an essential factor of production for small scale farmers with insufficient capital resource to invest. A credit service is particularly indispensable for capital intensive farming like irrigation activities.

The study shows that, input and financial credits are the main credit types in the study area. Commercial fertilizer (Urea & DAP) and improved seed are the main input credit that can be received from local cooperatives. On the other hand local micro finance, Bureau of agriculture and rural development and other local cooperatives provide financial credits for diversified packages including livestock and irrigation development in the study area.

The credit access of the total households comprises 42% for input and 28% for financial credit. It is likely that those reporting an increased need for credit are reflecting the need to purchase inputs for more intensive crop production; whilst those reporting a decreased need are reflecting the high interest rate and even some of them they did not know whether there is such opportunity. Irrigation user households have more access to input credit than the non irrigation user households. Based on the group discussion this is due to the intensive cultivation of the irrigating farm land that deteriorates soil fertility utilization of fertilizer is crucial.

There are various saving experiences in the study area like the other parts of the region. The main saving types are as live livestock, Local group savings (Equb), jewelery and to some extent saving in financial institutions.

Figure 5.3, saving type of sample households

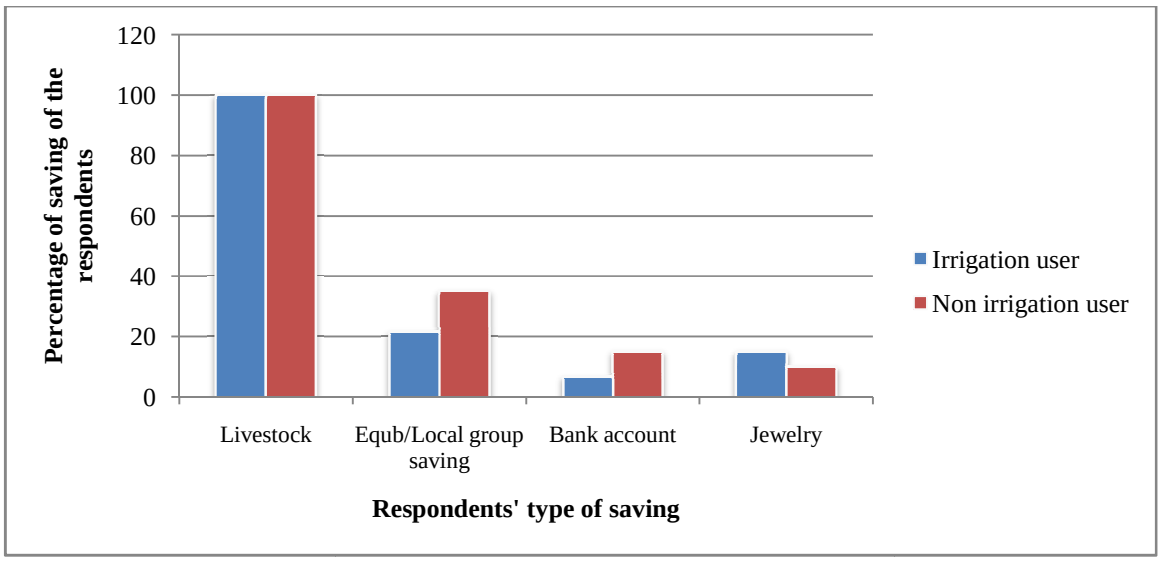


Figure 5.3 shows that, as rural farm households all of the sampled households have live livestock as saving that can be used for production or consumption at different times. The other saving type is local saving and lending group that have a number of people members that contribute some money and use it rotational the amount they saved. Jewelery is not directly considered as saving, it is used directly for personal decorating at different ceremonies but it is saved material that can be used through selling whenever needed. Some of the households have also started to save their money on financial institutions at the nearby city. There is no significant difference between the irrigation user and non irrigation user households in saving type.

5.5 Physical capital

Physical capital can be described as the basic infrastructure and producer goods needed to support livelihoods. This may include secure shelter and buildings (housing), household utensils

and farm implements and adequate water supply and sanitation, affordable transport, clean affordable energy and access to information (communications). Producer goods are tools and equipment that people use to function more productively.

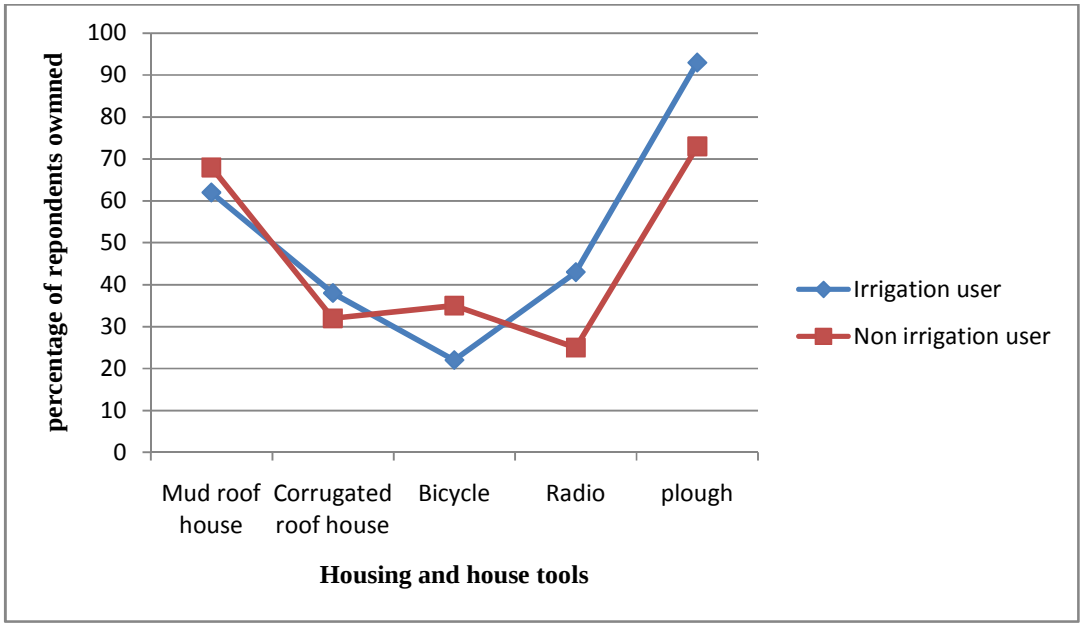
Housing, house utensils and farm implements are the main indicators considered in this study to compare the sampled households.

5.5.1 Housing and House tools

Types of housing are an indicator of improving the well-being of rural households. In rural areas of the region most of the houses are mud roof houses, but wealthier households will have a corrugated iron roof. As to the group discussion, farmers said that "as income increases, people start to rehabilitate their houses from mud roof to corrugate once".

The number of households owning mud roof house are more than corrugated houses (Figure 5.4).

Figure 5.4: Type of housing and main tools owned by the sample households



About 38% of irrigation user and 32% of the non irrigation user households have changed their houses to corrugated iron roof. However above 62% of irrigation user and 68% of the non

irrigation user households are still on mud roof house. A higher percentage of irrigation user households in the sample had corrugated iron roofed houses than non irrigation user households, but statistically there is no significant difference.

More over household tools and farm tools are also indicators of households to have the most developed physical capital.

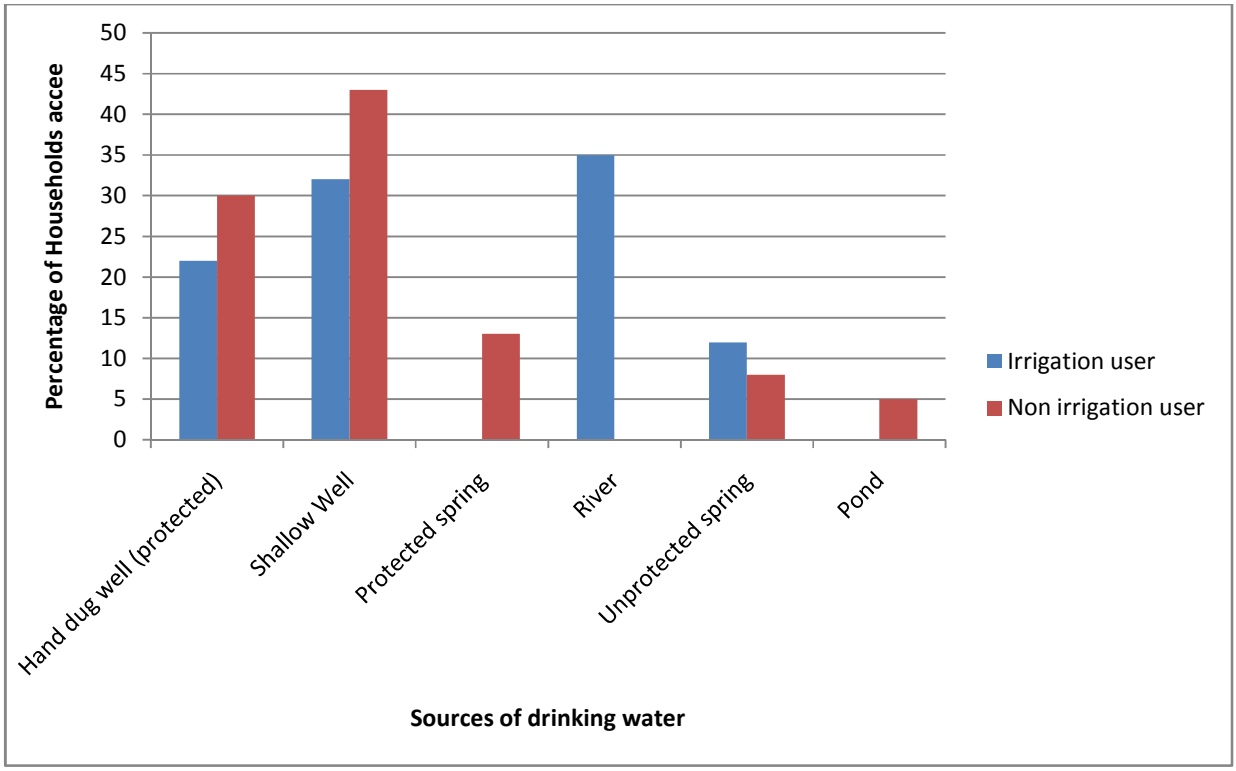
As showed in figure 5.4 the main household tools include bicycle, radio and farm tools/plough materials. Almost all of the farm households have their own plough material, and less in transporting bicycle and radio for recent information gaining. The study revealed that in both sample households there is no significance difference between the irrigation user and non irrigation user in main household tools.

5.5.2 Access to drinking water

Access to clean drinking water is the primary health indicator of human being. The main drinking water supply scheme in the study area are hand dug and machine drilled shallow wells, river, spring and ponds.

Bases on the interview of key informants, all of the drinking water schemes in the study area constructed or developed by government sector or NGO. Thus the difference in accessibility to clean drinking water focuses on the potential they have and their utilization. Since the irrigation user households are at the downstream of the watershed they do have more potential to ground and surface water potential.

Figure 5.5 Sources of drinking water of the sample households



It is observed that the irrigating have better access to water than the non irrigation user households for their domestic use like washing of closes, since the river is flowing across their village. But the accessibility of drinking water schemes is almost the same in the two sampled villages. Despite the availability of the schemes the proper utilization of the schemes is less. It is revealed that little is known on the difference of underground water flowing water effect on their health. Especially in the irrigating village it is common to use river water for drinking, though there is hand pump installed drinking water wells. Moreover there no strong water user committee for efficient utilization and management of the drinking water schemes.

5.6 Social capital

Social capital refers to the institutions, relationships and norms that shape the quality and quantity of a society's social interactions. There are a number of key sources of social capital:

families, communities, businesses, civil society, public sector, ethnicity and gender. (DFID, 2002). It is the other important type of capital, which refers to the social resources up on which people draw in pursuit of their livelihood objectives. According to Ellis (2000), social capital can be described as the social networks and associations to which people belong. They comprise social relations like access to or membership of networks, association, groups, and cooperatives, relationships of trust and allegiances. As initiative to develop community groups could give way to a number of benefits including:-

- Improvements in human capital through group literacy and skill training
- Improved access to loans, through group lending mechanisms
- Improved capacity of speaking out issues of concerns of community

The initiatives are important to develop social capital within the group, between the groups and other networks.

Social capital is not easily measured, as it relates to many resources and processes, including the less tangible resources upon which people draw, networks and complex patterns of obligation, membership of groups and relationships of trust, reciprocity and development and sharing of knowledge.

5.6.1 Formal and non formal networks

Based on the group discussion the main social networking means in the study area includes cooperatives, development groups, Edir/Mahber, saving and lending groups and religious events. Edir/Mahber is a social group established by the community for supporting each other in special events like mourning and marriage. This is used also as a means of information dissemination means among the group members. Development group is a new strategy of networking people for sharing experiences and knowledge transfer. This is new program that includes all

households' separately men and women group. One development group has 25 members of household heads with five sub group for networking and mainly focuses on agricultural activities, extension and intervention. Moreover there is women's group with the same number that participate every woman whether head or not focusing on health and education information exchange and knowledge sharing through their network.

The study revealed that the membership of the sampled households in existing cooperatives and institutions is low in the formal cases except in development group. Of the sampled households 43% of irrigation user and 30% of non irrigation user households are members of the PA level cooperative. This PA level cooperative is established by government to facilitate supply of agricultural inputs like fertilizer, improved seed, beehives, and basic goods for household consumption for their members. In the case of credit and saving institution it is young for the community that to evaluate at this stage. However there is no irrigation cooperative in the irrigation scheme that may have its contribution for low productivity. For example, O&M for the irrigation scheme is generally undertaken by mobilizing farmers on the basis of landholding by the irrigation water distributer committee. This committee (*Abo mai*) has five members for arranging irrigation water allocation only.

In the case of non formal groups above 68% of the irrigation user and 87% of the non irrigation user households are members of Edir/Mahber, and 22% of irrigation user and 35% of the non irrigation user households are members of Equb. There is no significance difference between the irrigation user and non irrigation user household in membership of the non formal cooperatives.

In labour mobilization traditionally the 'Lifnti' system ensured labour available for the major agricultural tasks. 'Lifnti' is sharing of labour for agricultural tasks including assist with land preparation, weeding and harvesting, and/or ox for plough of their cultivated land. The survey

suggests it was widely used, and that there was a social willingness to assist people who were in difficulty share each other their labour in the community. The system is still widely used in both of the sampled households.

5.7 Main factors in the small-scale irrigation

Small-scale irrigation has immense potential to improve the incomes of poor rural households in developing countries like Ethiopia. However, the performance and effectiveness of both traditional and formal small-scale irrigation schemes are constrained by multidimensional problems ranging from individual farmers' attitude to institutional arrangements. A field survey with focus group discussion and key informant interviews indicate that small-scale irrigation's benefits are accompanied with multidimensional problems. The major constraints for small scale irrigation in study are ranked below based on their severity.

i. Loss of water through canal seepage: This is the main problem in small-scale irrigation systems in the study area. The earthen canal structure of the irrigation scheme and the vertisol nature of the soil in study area cause high water seepage from the river diversion canals. Seepage from irrigation canals is the main causes for water losses in the scheme. Most of the water lost at the main and distribution canals. The downstream beneficiaries didn't get enough water mostly except as supplementary during the end of the rainy season. Frequent damage of the earthen canal has been reported that valuable farming time of the community tends to be lost at the end of each rainy season on repair and construction work.

Picture 5.2. Water loss through seepage from the main canal of the scheme, Semha.

ii. Inadequate farmers' knowledge and experience in irrigated agriculture: in the study are experience of irrigation agriculture last for many years, but still there is no awareness on effective utilization of irrigation water based on crop water requirement. Therefore, lack of experience and skill is ranked as second problem next to water loss problem. Based on the group discussion there is no enough support structure in agricultural extension for irrigated agriculture from agriculture office. Irrigation is just seen as the other seasonal packages of program. Most of the farmers harvest twice a year. However their harvest is lower than their rain fed harvest.

iii. Lack of water user committee: Water user committee is the main responsible body for managing any irrigation scheme including operation and maintenance, fee collection, fair distribution and other activities that increase the efficiency of the irrigation water. However the survey revealed that, there is no committee formulated to do that in study scheme except five persons that had been assigned for water distribution. Hence repairing of the canal and protecting against any misuse activities that might damage the canal and over the entire

irrigation scheme is less practiced. The beneficiaries of the irrigation mend the canal when there is any canal damage at the end of the rainy season only as community mobilization.

iv. Crop diseases: based on the key informants' interview the study area is intensively cultivated with the same crops for long periods of time. In addition to the loss of productivity and fertility, this cultivation strategy facilitates crop disease. Imported inputs to control these problems, such as herbicides and pesticides, are costly for farmers to purchase some are ineffective. Thus diseases and pests are the limiting factors for the economic benefits of small-scale irrigation activities in the study area.

v. Lack of necessary inputs: it is interrelated with the farmers' awareness and supply. Inputs such as vegetable seeds, fruit seedlings, crop pesticides and improved seed fertilizers are not accessible. In case of commercial fertilizer the price is not affordable. Based on the informants' information the application of fertilizers on their farm plots is below the recommended levels. In addition there is no irrigation cooperative that can facilitate input and market supply in the study area.

vi. Problem of water distribution: Based on the group discussion and key informants interview irregular water distribution was the main problem that causes water logging at the upper and shortage of water at the downstream of the command areas. On the other hand there has been no standardized watering interval to each crop cultivated. Water is distributed by turns of equal duration throughout the irrigation season simply following spatial order of plots, regardless of the crop cultivated, time interval of water application and the size of each irrigated land sizes. Thus, poor distribution system and inefficient use of water resource is the common feature of the small-scaled irrigation scheme in the study area.

vii. Lack of coordination between institutions dealing with irrigation development. Based on the key informants' response less integration between Agriculture office and water resource office is the source of mismanagement and water loss in the irrigation scheme. The construction structures and establishment of water user committee is the responsibility water resource office and the agronomic practice is duties of Agricultural office. However Water resource office emphasizes on physical works mainly in design and construction but not in irrigation management which require a detail understanding of agricultural process and the farming community. Moreover, the Agriculture office of the District is often undertakes its programmes as campaign and package form not at specialized format. Therefore, this divided pattern of organization has had unsatisfactory result on the overall achievements of the irrigation development.

viii. Lack of market and marketing facilities: in the group discussion the main market problems was described as the similarity of products and marketing patterns; Carrot and Onion, the dominant cash crops, often harvested by farmers at the same time, which leads to a high availability and low prices during the main marketing period. Compounding this, because there is no efficient storage system in the study area, products quality deteriorates rapidly, which means that farmers must sell within a very short time, often they consider this to result for low prices. Lack of storage facility and absence of proper functioning farmers' cooperatives cause's farmers bargaining power especially on the marketing of cash crops is low. Moreover, there has been a culture of open grazing system during the dry season, which resulted in canal and crops damage by livestock. All the mentioned constraints forced farmers to cultivate cereals besides to their lack of experience on cash crop production.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study was conducted in Enderta district of Tigray region, northern Ethiopia, on one small scale irrigation scheme (river diversion) village comparing with adjacent village with no irrigation access. Farming is the main livelihood for all of the households in the study area. The objective of the study was to assess the impact of small-scale irrigation on the livelihood of rural farm households and identifying the main irrigation factors in the study area. This was done through comparing livelihood assets of irrigation users and adjacent non irrigation users.

The findings of the study shows that there was no significance difference in their livelihood between irrigation and non irrigation user households.

Access to education, training, knowledge transfer and information exchange of the irrigation user and non irrigation user households were compared for human capital. 70% of the irrigation user and 62% of the non irrigation user were participated in different types of training including crop production and livestock management. However 44% of the participated farmers were not satisfied and it was less useful for their agricultural practice. Little has been done on knowledge sharing through extension workers especially on the irrigation area that need close follow and continues learning for increased productivity. There was no difference in sending of children to school and labour availability between the irrigation user and non irrigation user households. There is no significance difference between the irrigation user and non irrigation user households on their human capital.

On physical capital 38% of the irrigation user and 32% of the non irrigation households have changed their houses to corrugated iron roof. There was no difference in access to drinking water except the type of scheme they have. The irrigation user and non user households have similar land holding size. Soil fertility of the irrigated areas is less than the non irrigated lands. This is due to intensive utilization of the land and non organic input application that deteriorate the natural soil fertility. On social capital there was no difference between the irrigation and non irrigation user households due to irrigation access, though it is difficult to measure directly.

The main income sources of rural household in the study area are cropping, livestock and off-farm activities. The study revealed that mean annual income of irrigation user is significantly larger than non-irrigation user households. However the non irrigation user has higher income from off farm and nonfarm activities than the irrigation user households.

Based on the focus group discussion the annual income of irrigating has expected be higher than those non irrigating households. However the survey result shows there is no significance difference in annual household income between irrigation user and non irrigation user households.

The findings of the study show that there is no difference on their overall income and livelihood capitals between the irrigation user and non irrigation user households of the study area.

The study revealed that are inadequate farmers' knowledge and experience, canal seepage, lack of water user committee, are the main constraints of irrigation that affect the irrigation development in the study area.

6.2 Recommendations

Irrigation is a progressive activity that need basic trainings and close follows up. Training is one of the indicators in human capital that helps to share farmer's experience, knowledge and

technology transfer for better productivity and improve livelihood. Hence trainings should be demand driven and as per the gap of knowledge and experience of the beneficiaries. Technical training for farmers on efficient utilization of irrigation water, cash crop and fruit production, crop water requirement and marketing is critical to increase crop yield and income from irrigation. Therefore such trainings should be given based on the demand and gap of the irrigation and beneficiaries. Farmers' sharing of experiences on irrigation practices and individual close follow up by the extension workers on farming activities is vital that will have great effect on their production.

Water loss through canal seepage is one of the basic factors for low crop production due to earthen and unstable canal. Therefore responsible bodies should give focus on line/cemented canal construction for minimizing water loss due to seepage, water logging, and to increases the amount of water flowing for downstream beneficiaries.

Coordinated institutional support should be given by the Office of Agriculture and water resource office of the district for improving the irrigation scheme. Continuous monitoring and evaluation of irrigation schemes is necessary to provide feedback and information important to solve any problem related to the scheme. Bottom-up approach is ideal for irrigation development, treating farmers as owners and not as beneficiaries of the projects. Creating sense of ownership by participating farmers throughout the project planning and implementation to make farmers more responsible on the scheme is vital.

It is crucial to develop farmer managed irrigation schemes and managing committee, as they reduce the financial and work burden on the government in terms of operation and maintenance

of the scheme structure. Establishment of irrigation cooperative groups can also enhance farmers information sharing and solve the problems of input and market access.

REFERENCES

Abdinasir I. Small *holder dairy production and dairy technology adoption in the mixed farming system in Arsi highland, Ethiopia* [Dissertation]. [Germany (Berlin)]: Humboldt University,2000.

Agrawal, A. *The role of local institutions in adaptation to climate change*. Washington D.C.: The World Bank, Social Development Department, 2008.

Alukonya, S. Mwea irrigation agricultural development project in Kenya. *Poverty in irrigated settlements*, A discussion Paper and replies from Network members, ODI Irrigation management Network, Network Paper 7, 1993.

Awulachew, S. B., D. J. Merrey, A. B. Kamara, B. Van Koppen, F. Penning de Vries and E. Boelee with editorial assistance from G. Makombe. *Experiences and Opportunities for Promoting Small-Scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia.* IWMI Working Paper 98. Colombo: IWMI, 2005.

Awulachew, Seleshi Bekele; Lambisso, R.; Asfaw, G.; Yilma, A. D.; Moges, S. A. *Characterizing, assessment of performance and causes of under performance of irrigation in Ethiopia.* Ethiopian Journal of Development Research, (In press), 2010.

Banik, D.(ed), *Poverty, Politics and Development: Interdisciplinary Perspectives.* Bergen: Fagbokforlaget, (2006).

Bargahvas (Dr.) B.S. *Minor Irrigation Development Administration* (A study in an Indian State), Ashish Publishing House, New Delhi, India, (1980).

BCEOM. *"Abbay river basin integrated development master plan*, section II, volume V – Water resources development, part 1 – Irrigation and drainage." Ministry of Water Resources, Addis Ababa, Ethiopia, 1998.

Bebbington, A. "*Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty*." World Development 27:2021-2044, 1999.

Brown E.P. & R. Nooter. *Successful Small-Scale Irrigation in the Sahel.* World Bank Technical Paper No. 171, Washington D.C (1995).

Chambers, R. *Rural Development:Putting The Last First:* New York. John Wiley and Sons Inc, (1983).

Chambers, R *Managing Canal Irrigation*. Cambridge, Cambridge University Press, (1988).

Chambers, R., & Conway, G. *Sustainable Rural Livelihoods*: Practical Concepts for the 21st Century, (1991).

Chenje, M., Solar, C., .Manzungu, E. *The State of the Environment in Zimbabwe*, Harare, MMET, (1998).

CSA. *Statistical abstract*, Addis Ababa, Ethiopia, (2007).

Davies, S., and N. Hossain. "*Livelihood adaptation, public action and civil society: a review of the literature.*" University of Sussex, Institute of Development Studies Working Paper 57, 1997.

Desalegne Rhameto. *Water Resources Development in Ethiopia: Issues of Sustain Abilities and Participation*, Forum for Social Studies, Addis Ababa Ethiopia, (1999).

Desta Beyera. *Impact of Community Managed Irrigation on Farm Efficiency and Household income;* the case of Weliso and Wenchi Districts of Oromia. Unpublished M.Sc Thesis, Haramaya University, (2004).

DFID. *The Economics of Maintaining Irrigation Systems*. DFID's Water KAR (Knowledge and Research) Projects. R8027. October 1996- September 1997, 1997.

DFID. *Contribution of irrigation to sustaining rural livelihoods*. DFID's Water KAR (Knowledge and Research) Projects. R7879. March,2002.

Donald Campbell. *Design and Operation of Smallholder Irrigation south Asia.* (W.B Technical Paper No. 256), Irrigation and Drainage series Washington D.C., (1995).

Eakin, H. "*Institutional change, climate risk and rural vulnerability*: cases from central Mexico." World Development 33:1923-1938., 2005.

Ellis, F. *Rural Livelihoods and Poverty Reduction Policies*: London ,Routledge. (2000).

Ellis, F. & Freeman, H. A. *Rural livelihoods and poverty reduction strategies in four African countries.* The Journal of development studies, (2004), P. 40**,** 1-30.

Ellis, F. & MDOE, N. (2003) *Livelihoods and rural poverty reduction in Tanzania*. World Development, (2003), P.31**,** 1367-1384.

Enderta Agriculture and Rural Development Disaster Management & Food Security Sector, *2012/13. Crop production data & report,* Enderta, Ethiopia, unpublished, 2013.

Enderta Water resource office *annual report, 2012/13,* Kuiha, Ethiopia, 2013.

FAO. *Water Sector Policy Review and Strategy Formulation.* Land and Water Bulletin 3. World Band, UNDP, 1995.

FAO. *Food Production: the critical role of water*. Technical Background Document 7, World Food Summit, 1996. Rome, FAO.

FAO. *The state of food an Agriculture proceedings of FAO experts' consultation*, Rome, Italy, (2000).

FAO. *Irrigation in Africa South of the Sahara*. FAO Investment Center Technical Paper 5. FAO: Rome,(2003).

FAO. *Agricultural populations and households*, agri-gender statistics Toolkit: data items, Accra, Ghana, (2010).

Gebremedhin B. and Peden D. *Policies and Institutions to Enhance the Impact of Irrigation Development in Mixed Crop-Livestock* [Internet]. MoWR/EARO/IWMI/ILRI Workshop; Addis Ababa, Ethiopia, (2002). [Cited2011 March 13].http://publications.iwmi.org.

Grove, A.T. *The Changing Geography of Africa*: Wadsworth, Belmont, (1989).

Hagos F, Holden S. *Rural Household Poverty Dynamics in Northern Ethiopia 1997-2000*. Paper for CPRC Conference, Manchester, 2003.

Hasnip, N. et al. *Contribution of Irrigation to Sustaining Rural Livelihoods*. Literature Review. Report O D/TN 109, September 2001, HR W allingford, UK, 2001.

Hussain, I., Hanjra, M.A. *Irrigation and poverty alleviation*: review of the empirical evidence. Irrigation and Drainage, Tehran, 2004 p.53.

Hussain, I. *Irrigation and poverty alleviation: pro-poor intervention strategies in irrigated agriculture in Asia*. Paper presented in 4th Asian Regional Conference & 10th International Seminar on Participatory Irrigation Management. 2-5 May, 2007, Tehran, Iran, 2007.

Lankford, B. *Irrigation-based livelihood trends in river basins: theory and policy implications for irrigation development.* Physics and Chemistry of the Earth, 817-825, (2003).

Maddison A. *Economic progress and Policy in Developing countries,* New York: W.W.Norton and Co., 1970, pp. 34.

Mekuria, T. *Small-scale irrigation for food security in sub-Saharan Africa*. CTA Working Document,Ethiopia, (2003).

Michael A.M. *Irrigation Theory and practice*. Vikas Publishing House pltd Newdelhi, India, (1997*).*

Miller G. *Environmental Science* .An Introduction, Wadsworth, Belmont, (1982).

MoFED. *Trends and prospects for meeting MDGs by 2015, millennium development goal report.* [Internet]. [cited 2011 July 4]. Addis Ababa, Ethiopia,2010. Available from: http//www.dagethiopia.org.

Moll, H.A.J. *Small Holders And Relationship Clusters With Rural Institutions*. Weavers Press, Harare, (2004).

Moris, J. *Irrigation as a privileged solution in African development,* Development Policy Review, 1987, P.5: 99-123

MoWE. *Water and Development quarterly bulletin 5*. MWR: Addis Ababa, 2011.

Patnaik, U. *Economic and political consequences of the green revolution in India*. In: Bernstein, B., Crow, B., Mackintosh, M. and Martin C. (eds), The Food Question: Profits versus People? London: Earthscan Publications,1990.

Punnet, W. *Man, Land and Resources:,* Yew York. Macmillan, (1982).

Rees Ton & Kees Dejong. *Irrigation Technology and Social Change: An analysis ofthe Social Variable of Technology: Journal of Developing Areas,* Vol.25, No. 2 January 1991. Ed. Ill ions University, 900 West Adams street, U.S.A, (1991).

Schilfgaarde VJ. "*Irrigation, a Blessing or a Curse*"; Agricultural Water Management, 1994, P.25: 203-219.

Scoones, I. e. a. *Hazards and Opportunities: Farming Livelihoods in Dryland Africa, Lessons from Zimbabwe*. Brighton, Institute of Development Studies at the University of Sussex, (1996).

Seleshi Bekele; Awulachew; Yilma, A D.; Loulseged, M.; Loiskandl, W.; Ayana, M.; Alamirew, T. *Water resources and irrigation development in Ethiopia*. Colombo, Sri Lanka: IWMI Working Paper 123, 2007, P.66.

Seleshi Bekele; Awulachew; Teklu,E.;Regassa,E. *Irrigation potential in Ethiopia: Constraints and opportunities for enhancing the system.* Colombo: IWMI. (Working paper), 2010.

Shah, T.; van Koppen, B.; Merrey, D.; de Lange, M. and Samad, M. *Institutional alternatives in African smallholder irrigation: Lessons from international experience with irrigation management transfer*. Research Report 60. Colombo: IWMI, 2002.

Shanan, L. *The impact of irrigation*. In: Wolman MG, Fourner FGA, editors. Land Transformation in Agriculture. Publishers: Wiley, J & Sons Ltd., 1987.

Teshome Atnafie. *Irrigation Policies, Strategies and Institutional Support Conditions in Ethiopia.* Proceedings of Symposium on Best Practices and Technologies for Agricultural Water Management in Ethiopia, March 7-9, 2006, Addis Ababa Ethiopia, (2006*).*

Troeh, F.R and Miller, G. *Environmental Science. An Introduction*: Wadsworth, Belmont.

Underhill H.W. 1990. *Small-scale irrigation in Africa in the context of rural development.* Crafield Press, Bedford, UK, (1980).

Zewdie M, Moti J,Ascimelis G..*Assessment of Wendo Wesha irrigation scheme in Awassa Zuria*. Proceedings of research project completion workshop; 2007 Feb 1-2; Addis Ababa, Ethiopia, 2007.

APPENDIX I

Tables of crop value and conservation factors

Table I.1 Average crop value in ETB in 2012/2013 production yearn

Major crop types	Crop value in ETB
Maize	600
Teff	1300
Wheat	700
Barley	650
Lentile	1100
Carrot	1500
Garlic	2100
Potato	1200
Enguaya	1000
Onion	800

Table I.2: Conversion factor for Tropical Livestock Unit (TLU)

Livestock Type	Livestock Unit (TLU)
Ox	1.10
Cow	1.0
Heifer	0.50
Bull	0.6
Calves	0.20
Sheep	0.01
Goat	0.09
Donkey	0.5
Horse	0.80
Mule	0.7
Poultry	0.01

Source: Abdinasir, Ibrahim (2000)

APPENDIX-II

The questionnaire is prepared to undertake a study on *the effect of small-scale irrigation on Livelihood of rural farm households***.** The purpose of the questionnaire is to gather information on irrigating and non-irrigating household's livelihood assets and factors that affect irrigation on Semha diversion. Dear respondents, the result of this study will help different stakeholders and policy makers to make appropriate measures on irrigation development in the future. Therefore, you are kindly requested to provide genuine responses. Thank you for your time and cooperation!

Household survey questionnaires

A. Demographic and socio economic household questionnaires

1. Enumerator's name _____
2. Date of interview:_____
3. Name of Village_____
4. Name of the respondent_____
5. Sex_____ 1= male 0= female
6. Marital status: 1= single 2= married 3= divorced 4= widowed 5= other_____
7. Age of respondent_____
8. Give details about occupation and education levels for household members

Note: Under occupation and education level specify for each household member, for school going children probe and if not applicable, indicate so.

No.	Name of HH members	Sex	Age	Marital status	Occupation	Education level

Sex: male = 1, female = 2;

Age: <15=1, 15-64=2, >64=3

Marital status: single = 1, married = 2, widowed = 3, divorced = 4, separated = 5, never married = 6

Education level: no education illiterate=1, no education literate=2, primary school = 3, secondary = 3, College = 4, other (specify) =5

Occupation: Farming=1, Petty trade=2, Traditional healer=3, builder=4, guarding=5, other=6

B. Agricultural production, income sources, Assets owned

9. What was your crop land holding size of your family in ha?
    1. Rainfed _____ ha, 2. Irrigation_____

    Area (ha) for rain fed <1=1, 1-1.5=2, 1.5-2=3, >2=4

    Area (ha) for irrigation <0.25=1, 0.25-0.75=2, 0.75-1=3, >1=4
10. According to your local classification soil fertility, your farm is 1. Fertile 2. Medium 3. Poor
11. Are you irrigation beneficiary?1=yes→**Q.13** ,2=No
12. If your answer for Q.11 is no, what is the total yield and income received from crop production in the last 12 months?

S/N	Type of crop	Area sown in ha	Yield in Qtl.	Estimated price/kg in ETBbirr	Amount Sold in kg	Income /ETB
1	Maize					
2	Teff					
3	Sorghum					
4	Barely					
5	Chick pea					
6	Wheat					
7	Oil seeds					
8	Others (specify)					

13. If you are irrigation beneficiary, what is the total yield, estimated prices and income received from crop production from irrigation and/or Rain fed in the past 12 months?

S/N	Type of crop	Irrigated					Rain fed					Total Income in birr
		Area (ha)	Yield in Qtl	Estimate price/birr	Amount Sold in kg	Income in birr	Area (ha)	Yield in Qtl	Estimate price/birr	Amount Sold in kg	Income in birr	
1	Maize											
2	Teff											
3	Sorghum											
4	Barely											
5	Vetch											
6	Wheat											
7	Onion											
8	Tomato											
9	Carrot											
10	Cabbage											
11	Lettuce											
12	Paper											
13	Garlic											
14	Potato											
15	Spices											
16	Others(specify)											

14. Do you think the production from irrigation is low in the production year?

    1=yes,2=No→**Q.16**

15. If your answer for Q.14 is yes, what were the constraints to low production? Rank based on their severity.

Code	**Constraints**	**Responses**	
		Rank (1, 2…)	**Main Reason**
1	Low access to inputs		
2	Shortage of irrigation water		
3	Lack of skill		
4	Labor shortage		
5	Low access to market/infrastructure		
6	Market price fluctuation		
7	Pests		
8	Others(specify)		

16. What type of inputs did you use for the crop specified in Q.13

    1= Urea/DAP (kg) _____, 2=Compost _____, 3=Manure(qtl) _____

    4=Chemicals (pest/insecticide)(lit)_____, 5=others specify

17. Have you/any of your families participated in off farm activities that can generate income in the past 12 months? 1=yes, 2=No→**Q.19**

18. If your answer is yes, in which of the following off farm activities did you/your family participated in the last 12months and what was your income?

S/N	**Activities**	**Income in Birr /year**
1	Community based Cash/food for work other than PSNP	
2	PSNP	
3	Construction/building	
4	Petty trade	
5	Weaving	
6	Sale of fire wood / charcoal	
7	Bee production and Honey/colony sale	
8	Stone quarry	
9	Guarding	
10	Others specify	

19. Did you have own livestock? 1= yes 2= No→**Q.21**

20. If your answer for Q.23 is yes, did you get any income from the sale of livestock and their products in the past 12 months? If yes, indicate type and total sale.

No	Livestock type	Number kept	Estimated prices/birr	Number sold	Income in birr	Products	Total Income in Birr
1	Cattle						
2	Sheep						
3	Goat						
4	Horse						
5	Donkey						
6	Mule						
7	Camel						
8	poultry						
9	Other specify						

Products type: Milk=1, Meat=2, butter= 3, Eggs=4, Hides/skins=5, other (specify) =6

21. What were the other sources of your income in the past 12 months? 1=Remittance _____Birr, 2=Pension _____Birr, 3=Others/specify _____Birr

22. Do you have access to credit?1=yes, 2=No

23. If your answer for Q.22 is yes for what type of credit do you have access? 1=Input, 2=financial

24. Did you think that you are benefited from accessing to credit? 1=yes, 2=No

25. What were the main constraints to credit access and utilization? 1=interest rate, 2=access, 3=collateral, 4=others(specify)
26. What types of saving did you have at your household? 1=Equb, 2=Local institution, 3=material type, 4=others specify
27. What were the main sources of income for your household?

    1= crop production, 2=Livestock, 3=off farm and nonfarm activities, 4= other specify
28. What are the sources of water for domestic use that you are using?

Code	Sources of drinking water	(√)
1	River	
2	Unprotected spring	
3	Pond	
4	Hand dug well (open/unprotected)	
5	Hand dug well (protected)	
6	Protected spring	
7	Drilled Well	
8	Others(specify	

29. What are the main problems of drinking water supply in your area?

Code	Determinant factors	(√)
1	Shortage in quantity	
2	Poor water quality	
3	Operation of the source is faulty	
4	Poor Management of water point	
5	Maintenance of the water point	
6	Distance/travel time	
7	Waiting time is too long	
8	No problems	
9	Others (specify) _____	

30. What physical assets do you have?

S/n	Assets type	Quantity	When acquired	Approximate value in Birr

Asset: corrugated iron House=1, mad house =2, thatched roof house=3, Bicycle=4, Radio=5, bed=6, TV=7, Jewelry=8, Farm implements (*list as below*) =9

Farm implements: Treadle pumps=*a*, Plough=*b*, Waterpump=*c*, Ridger=*d*, horse-drawn cart=*e*, Other (specify) =*f* …….e.g. 9*a*, 9*b*, *etc*

31. Are you a member of any cooperative? Yes=1, No=2→**Q.33**
32. If your answer for Q.32 is yes, what type of cooperative is it? 1=Local Saving and credit, 2=marketing cooperative=2, irrigation cooperative=3, PA level cooperative 4=others specify
33. Are you a member of any social institution in your PA? if so in what? 1=Edir/Mahber, 2=Equb, 3=other specify
34. In what way did you get agricultural information mostly?
35. Have you ever visited by development agents for/on your farm activities? 1=No→**Q.37** 2=Yes.
36. If your answer for Q.35 is yes how many times 1=fortnight, 2=once a week, 3=once in a month, 4=twice a year, 5=once per year, 6=never, 7=other specify
37. Is there a water user association that oversees the irrigation scheme? 1=Yes, 2=No→**Q.39**
38. How do you value the performance of the water user association? 1= Excellent, 2=Very good, 3=Fair, 4= Poor, 5=Very poor
39. Have you received any training?

Type of training	Who gives you the training?	When was the last training offered?	How did you find the training?
Crop production			
Livestock management			
Moisture conservation			
Soil fertility management			

Rainwater harvesting			
Irrigation development			
Post-harvest handling			
None			
Others specify			

Who participated in the training? Irrigation farmers=1, water user association members=2, non irrigating farmers=3, Other (Specify) =4

How did you find the training? useful=1,,less useful=2, Useless=3, Do not know=4

15. What type of training regards to irrigation would you like to receive in the future?

Any comment……

C. Focus Group Discussion

Checklists for focus group discussion for irrigation users

- Date _____

S/n	Group members name	Sex	Age

1. How do you manage your irrigation system (construction, maintenance, operation activities, water allocation, distribution, drainage etc)?
2. According to your opinion what is the negative and positive socio-economic impact of irrigation practices in your scheme?
3. In your opinion how do you judge the contribution of irrigation for household livelihood improvement?
4. Do you have institutional support from governmental offices?
5. What are the common problems of the irrigation scheme?
6. Rank the most hindrance/obstruction factors on your irrigated crops production.

S/n	Irrigation inputs	Rank-according the seriousness of the problem
1	Water	
2	Land	
3	Labor	
4	Inputs(fertilizer, herbicide, pesticide)	
5	Credit	
6	Market	
7	Pests/diseases	
8	Theft	
9	Skill	
10	Others(specify)	

D. Key informants Interview

Checklist for key informants on the irrigation scheme and beneficiaries

1. How irrigation is managed (design, construction, operation and maintenances, water distribution rules and regulations)
2. What are the major challenges faced to improve the livelihood of irrigation users of the Semha diversion?
3. What are the supports provided by you and your organization for irrigation users?
4. What are the major social and technical problems of the scheme?
5. What do you suggest for the improvement of irrigation in the district?