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Analysis of the impact of household's access to irrigation facilities on improving household's food security in Ethiopia: The case of Raya-Azebo Woreda, Tigray Region, Ethiopia

A Thesis submitted to the School of Continuing Education Indira Gandhi National Open University Maidan Garhi, New Delhi in partial fulfillment of the requirements of the Degree of Master of Arts in Rural Development (MARD)

By

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Declaration

I hereby declare that the Dissertation entitled '' **Analysis of the impact of household's access to irrigation facilities on improving household's food security in Ethiopia: The case of Raya-Azebo Woreda, Tigray Region, Ethiopia**'' submitted by me for the partial fulfilment of the requirements for the Degree of Master of Arts in Rural Development (MARD) to Indira Gandhi National OPEN University (IGNOU) New Delhi is my own original work and has not been submitted to IGNOU or other Institutions for the fulfilment of the requirements of any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from earlier works.

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LIST OF ACRONYMS

ADLI	Agricultural Development Led Industrialization
ARDD	Agriculture and Rural Development Department
Co-SAERS	Regional Commission for Sustainable Agriculture and Environmental Rehabilitation
DAs	Development Agent(s)
DCs	Development Committee (s)
DID	District Irrigation Desk
DESCI	Dedebit Micro-Finance Institution
EFSS	Ethiopian Food Security Strategy
EPRDF	Ethiopian People's Democratic Revolutionary Front
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FHHHs	Female Headed Household (s)
Ha	Hectare
HH(s)	Household(s)
HHH	Household Head
IDD	Irrigation Development Department
IWMI	International Water Management Institute
Km2	Kilometer square
MHHHs	Male Headed Household (s)
m	Meter
M	Million
M2	Meter Square
M3	Meter cube
Masl	Meter above sea level
MOA	Ministry of Agriculture
MOFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
N	Frequency (number of cases)
NGO	Non-Governmental Organization
Odi	Overseas Development Institute
O and M	Operation and Maintenance
PA(s)	Peasant Association(s)
PRSP	Poverty Reduction Strategy and Programme
RoWRD	Raya-Azebo office of Water Resource Development
SPSS	Statistical software package
SSA	Sub-Sahara Africa
SSI	Small Scale Irrigation
SSI	Small Scale Irrigation
SSIS	Small Scale Irrigation System
TU(s)	Territory Unit(s)
WFP	World Food Programme

WMC	Water Management Committee
WRD	Water Resource Development
WSDP	Water Sector Development Program
WUAs	Water Users Association (s)
WUTs	Water Users Team (s)

GLOSSARY OF LOCAL TERMS

"Abomais": Water Management Committees
"Belg": Short duration farming season
"Cluster": Team (Water Users" Team)
''Meher'' long duration farming season
''Sirit'' by-law (by which WUA would be governed)
''Tabia": Lower level administration (Peasant Association)

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Abstract

Access to irrigation facility is presumed to be a necessary pre-condition for improvement of the food security situation of farmers who have been facing the vagaries of food insecurity caused due to recurrent drought and erratic rainfall conditions. To this end, various government and non-governmental organizations (NGOs), among others, initiated small-scale irrigation schemes throughout the country including the Tigray region. Despite these efforts, however, smallholder farmers particularly in the study area are found to lease-out their irrigable land for dismal rental arrangement. This study therefore, assessed improvements witnessed in the overall food security situation of the target communities who have access to irrigation facilities. It also explored the type of institutional and organization set up and inhibiting factors in operating the irrigation schemes. A three-stage sampling procedure was used to first select peasant associations, followed by random sampling of deep-well boreholes and then categorization of target households as irrigating households and non-irrigating households in each irrigation schemes and finally sample respondents from each category. Both qualitative assessment and descriptive analysis techniques have been utilized to determine improvement in food security situation and assess institutional and organization set up of the two irrigation schemes.

The study revealed that irrigating households have been positioned better in terms of improvement in overall food security situation as measured by qualitative indicators: increased food intake both in term of varieties of food consumed and frequency of consumption, increase in money spent on education and health; changes in ability to cope with draught, reduce in crop failure and increased production, change in number of crops sold in income generating, increase in terms of employment opportunities, etc.

Furthermore, the study found that irrigating households have benefited much in terms of productive asset possession, increased income, increased crop diversification and intensification. In this regard, the analysis attested that irrigation participation, family labor force, livestock ownership, access to market information and credit are positively and significantly associated with household income and improvement in overall food security situation of the irrigating households. Hence, improving rural farm households' access to market information, credit facilities and technical assistance on irrigation management and use of improved agricultural practices is likely to improve participation in irrigation schemes thereby improve small holder farmers income.

Despite these positive impacts, the analysis revealed that the distancing by the bulk of farmers from irrigated agriculture through leasing out their plots to dismal rent arrangement provides a good indication of the lack of enthusiasm amongst them to commit themselves to irrigated cultivation. Key inhibiting factors revealed by the study were poor extension support in terms of supply of farm implements (improved seed, fertilizers and insecticides), lack of skill on irrigation management and improved agricultural practices, inadequate access to credit facilities, lack of market information and market linkage support. In essence, lack of government support was at the hallmark of these factors.

Generally, the result of this study shows that the development of irrigation schemes by itself cannot bring about significant change. Together with, it is important to consider the institutional and organizational aspects in order for irrigation systems to be successful.

Key words: Food security, Small Scale Irrigation, Institution and Income

CHAPTER ONE: INTRODUCTION

1.1 Background

Food insecurity, as a result of persistent drought among other reasons, has been the order of the day for a very long period in Ethiopia. Even during good years, the survival of some 4-6 million people depends on international food assistance (WFP, 2009).

The modern history of Ethiopia shows that the country has failed to adequately feed itself. Food deficit and famine occurrences in the country is claimed to be as a result of the erratic nature of rainfall or drought. Ethiopia has faced three large-scale drought induced food shortage and famine in recent times (i.e. in 1972/73, 1983/84, 2002/03), which claimed thousands of lives. In 2002/03 about 15 million people (over 20% of the total population) were under food aid need (WFP, 2009).

Despite the gloomy image, Ethiopia is endowed with a substantial amount of water resources. It covers 12 river basins with an annual runoff volume of 122 billion meter cube of water with an estimated 2.6 billion meter cube of ground water potential. This amounts to about 1743 meter cube of water per person per year: a relatively large volume. But due to economic water scarcity which is described through lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year with frequent crop failures due to dry spells and droughts. Moreover, there is significant erosion, reducing the productivity of farmland (IWMI 2009).

In order to address the multifaceted food insecurity in Ethiopia, the government has taken irrigation development as one of the most important tools that the country should give priority as a means of poverty reduction and maintaining food security. However, irrigation development in Ethiopia has been giving more emphasis to technical aspects with little attention to socio economics, and institutional factors that affect the outcome of the irrigation development (Woldeab, 2003). As a result of this, many irrigation projects developed in the country has faced many challenge to achieve their intended objectives. Therefore, this makes clear that experience of irrigation development in the last five decades in Ethiopia suggests that several measures need to be taken to support farmer managed small scale irrigation projects. Effective utilization of the existing water resource is therefore, very essential and mandatory to ensure sustainable livelihood and food security situation of the rural community in the country.

According to Uphoff.N (1989), 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. However, studies revealed that there are mixed outcomes on the impact of the on-going irrigation intervention both at national and regional level.

A study by IWMI (2009) revealed that there are a number of positive lessons that can be learned from successful schemes. Irrigation infrastructure has been increasing year after year, which may suggest some positive experiences with SSI in the region to justify the increase. Indeed, the current survey reveals evident successes on some schemes, where farmers admitted satisfaction in terms of improvement in incomes, as well as expansion of schemes (farm area) due to increased accessibility to water. However, these positive experiences were largely evident on traditional small-scale schemes. Farmers who have used traditional small-scale irrigation (these are mainly diversion schemes) for a long time seemed to have good experiences, local know-how and indigenous knowledge to take good advantage of emerging opportunities associated with interventions. Such farmers and communities were largely among the schemes identified as successful, which draws attention to the relevance of including local knowledge and know-how in small-scale irrigation development and planning. There is a general consensus that irrigation investments will achieve a broader poverty and food security impacts if efforts are geared towards revitalizing and up-grading of existing traditional small-scale irrigation schemes, with support to enhance access to input supply, output marketing and extension to facilitate access to information and innovations.

Poverty reduction in Tigray is a core policy agenda of the Ethiopian government in general and the regional government of Tigray in particular. A general consensus was reached that an increase in agricultural production and poverty reduction should come mainly through agricultural intensification and adoption of technologies that improve soil moisture to use more productivity enhancing inputs (MoFED 2002). The use of productivity enhancing inputs (such as fertilizer and high yielding variety) depends much on availability of moisture in which case, investment in irrigation becomes crucial. Despite the role of irrigation in easing the effect of rainfall uncertainty on agricultural performance, Ethiopia in general having an immense irrigation potential, has remained dependent on rain-fed and less productive agriculture, which resulted in food insecurity and sever poverty. To this end, the Ethiopian government in general and the regional government of Tigray have focused on rural investment on small-scale irrigation as a key poverty reduction strategy.

This paper provides an assessment of the impacts of these recent irrigation interventions in the study area and identifies further opportunities and constraints. In some parts of the regions, where there are scarce and erratic rainfall, there is evidence that irrigation has achieved positive impacts: better opportunity for production, better income, reduction of risks, and hence generated benefits for poor rural communities. Despite successes, there are also failures from which to learn in terms of technology choice, institutional set ups, support services that make such systems functional. There is a general perception that the current low performance of some small-scale irrigation schemes is related to a number of issues such as limited capacity, institutional instability, flawed project design and lack of adequate community consultation during project planning. Since there are yet significant potentials to be tapped, there are unique opportunities to adjust the drawbacks. If these constraints and drawbacks are overlooked, well-intended development efforts of governments and NGOs are likely to continue falling short of their intended impacts. The paper therefore attempts to assess the prevailing opportunities accrued to the communities by creating access to irrigation facilities along with assessing the extent of benefit accrued and concomitant factors inhibiting the achievement of the intended impacts in the study areas.

1.2 Statement of the Research Problem

Food insecurity has become a defining feature of many districts in Ethiopia exposing many households to face the grave tragedies of food insecurity in general and in Tigray region in particular.

To address the cyclical nature of food insecurity, the government has given due emphasis for designing appropriate strategies and policy directions to combat food insecurity sustainably. One among the major initiative considered in its WSDP policy document is addressing such food insecurity which is caused due to rain fed nature of agriculture in most part of Ethiopia through providing access for irrigation facilities that best suit the endowment of the specific localities. To this end, the government has formulated short, medium and long term plan to develop the existing water resources of the country best on its endowment (WSDP, 2002).

In line with this, the government has given due attention for development of ground water resource to utilize for irrigation purposes. Accordingly, the government has developed deep wells in areas where such potential is available and accordingly, 18 deep wells have been constructed in the study area under consideration with the view to improve the food security of the communities (RoWRD).

However, access to irrigation facilities may not necessarily ensure food security unless other issues such as institutional set up and water management system have been well considered as they have equal importance with access to achieve the intended objective of the intervention. Hence, the study will try to assess and analyze the impact of the irrigation facilities in improving household's food security along with exploring inhibiting factors for many farmers to opt for renting of their land located around the irrigation facilities for dismal rent remuneration.

1.3 Research Objective

The specific objectives are:

- Assess the impact of households' access to irrigation water from deep water wells on improving food security;
- Explore factors inhibiting households to fully engage in irrigation practices;
- Explore the institutional and management practices involved in operating small scale irrigation facilities that contribute to improve the efficiency and outcome of the operation

1.4 Research Hypothesis

The central research question raised for addressing the objectives of the research is the following:

What improvements in the overall food security situation of the target group where noticed due to creation of access for irrigation facilities and what institutional set up would facilitate farmers to fully engage in irrigation and derive maximum benefit out of the intervention.

The Specific questions are:

- Does the constructed deep wells payoff in improving household's food security?

- Why farmers located in the constructed deep wells are opting for renting their land to third party to receive dismal return?
- What institutional set up and water management practices would allow farmers to get the intended benefit out of the intervention?

1.5 Scope of the study

The study focuses on analyzing the impact of creating access to irrigation facilities on ensuring food security situation of the target communities with major focus being in its institutional arrangement and water management systems. This study is limited to only one district because of the limited time and resource. The district where the study will be conducted is Raya-Azebo. It is found in the southern zone of Tigray Region. This district is selected because of the researcher's attachment to the project areas and the relatively better irrigation practices with the application of deep well as communal small scale irrigation.

1.6 Significance of the study

The Ethiopian government has developed a 15-year water development project for the period 2002-2016 in order to enhance the appropriate and comprehensive water use policies and related institutional arrangements (WSDP, 2002). It ensures multiple uses of this vital resource among various users. Among the water sectors, agricultural water use has got the most attention through the strategy called Agricultural Development Led Industrialization (ADLI). The intervention of the plan is to address most of the supply-demand gap within 15 years' time through increasing the number of large, medium and small scale irrigation schemes. In addition, the Government of Ethiopia (GoE) recognizes, community managed small-scale irrigation water schemes as viable alternative to privatization and state ownership of the resource.

Studies indicate that access to irrigation facilities alone couldn't materialize the achievement of the desired outcome unless it is subsided by effective institutional arrangement and proper water management system. Hence, identifying, analyzing and understanding the existing institutional arrangement and water management system and willingness of the household to fully engage in the constructed irrigation schemes will pay-off significantly to ensure sustainable improvement of households' food security, better management of the constructed irrigation schemes and ultimately executing appropriately the government strategy of poverty reduction. Therefore, the outcome of this study may serve as a source of additional information for use by policy makers and planners during the design and implementation of irrigation development programs and prospects.

CHAPTER TWO: RESEARCH METHODOLOGY

2.1 Method of data collection

2.1.1 Primary Data Collection

For this study, the main source of information was from target irrigation users. Therefore, much emphasis has been given to farm households primarily to acquire pertinent data as they are the primary source of the information. Hence, the main data was collected through a questionnaires survey of the selected households in the study area.

Moreover, discussion has been made with key informants including committee members of irrigation water user's association, executive members of peasant associations, development agents and Irrigation Development technicians and experts from District cooperative desk and irrigation development sub process owner. Moreover, focus group discussions with water user associations and knowledgeable persons in the area have been conducted in order to enrich the analysis.

2.1.2 Sample size and sampling techniques

The study area, Raya-Azebo district has a total of 19 *tabias* (peasant associations and of which 9 *tabias* have access to deep-well irrigation facilities. The total household heads that have access to deep-well boreholes irrigation system in the sampled two *tabias*; Wargba and Kara are 319 and 314 respectively with total command irrigation area of 143 and 142 hectares respectively. In the sampled study area, a total of 9 deep-well boreholes (4 boreholes in Wargba and 5 boreholes in Kara) have been constructed for irrigation purpose and all are reported to be functional. However, three boreholes in each tabia have been sampled for the study having a total of 225 and 233 households accessing the irrigation facilities in Kara and Wargba locations respectively. Although the size of population of the two study sites differs, equal number of sample households was selected from each tabia for the convenience of the study.

The study considered a sample size of 60 households from the existing households who have access to irrigation facilities in the identified project location (sample frame). The following sampling techniques were employed to come up with a representative sample size.

- First, the lists of *Tabias* (Peasant Association) who have access to deep-well irrigation system were obtained and sampling of two *tabias* (PAs) were made using random sampling. Accordingly, Wargba and Kara Tabias were sampled as study location, which were considered as sampling frame.
- Second, sampling of three deep-well boreholes were made in simple random sampling in both Tabias (Pas); Accordingly, from Wargba *tabia*, *Selam-Wargba, Lemlem Wargba and Birhan-Adimokeni* boreholes were sampled and Kara-1, 2 and 3 boreholes were sampled from Kara *tabia*. The sampled boreholes in Wargba and Kara Tabias have a total of 233 and 225 households respectively, who have access to the irrigation system;
- Third, list of beneficiary households who have access to the selected boreholes were obtained from each *Tabia* and further the list have been filtered at two levels by categorizing them as irrigation practicing households and non-irrigation practicing households. The latter being households who have rented their land to other second party for dismal remuneration.

- Finally, for the survey, 20 households (from sampled boreholes in each PAs) of the first level of beneficiary category were selected using proportional sampling technique. And additional 10 households (from each locations) were also sampled from the second level of beneficiary category to indicate an insight of how the non-irrigation practicing households (who lease-out their land for dismal remuneration in the form of bonded contractual agreement) were losing the opportunities available to them for some unknown reasons to which the survey is interested to uncover and made future recommendations. In total, the survey would have 60 randomly sampled households as respondents to be reached through a household interview. Table 2.1 below depicts the sampled *tabias*, boreholes and households for the study.

Table 2.1: Name of tabias[1] and boreholes used in the study

S/N	***Name of Tabias used for the study***	***Sampled boreholes in study area***			**Sampled Household from each boreholes**		
		Name of Boreholes	***Command Area (Ha)***	***HHs who have access to the irrigation system***	***Irrigating households***	***Non-Irrigating households***	***Total***
1	**Kara**	Kara-1	42	120	11	5	16
		Kara-2	18	54	5	3	8
		Kara-3	17	51	4	2	6
		Sub Total	**77**	**225**	**20**	**10**	30
2	**Wargba**	Lemlem-Wargba	44	97	8	4	12
		Selam-wargba	39	86	8	4	12
		Birhan-Adimokeni	22	50	4	2	6
		Sub Total	**105**	**233**	20	10	30
		Total:	**182**	**458**	**40**	**20**	**60**

2.1.3 Designing Questionnaire

Before designing the questionnaire, the two irrigation systems were repeatedly visited in July and August 2012 summer season. During those periods a number of

[1] Tabias- peasant associations or lower level administrative hierarchy with in the district

informal discussions have been conducted with the beneficiaries, development agents and local government officials and the irrigation farm has been thoroughly visited. Based on the information gathered and personal observation, interview questions has been developed and then pre-tested before it was administered.

In order to conduct the household survey, enumerators who have completed 12th grade and able to speak the local language, Tigrigna, were recruited from each study sites. The enumerators were also trained by the researcher before launching the survey to make them understand the purpose of the survey and to be familiarized with the questionnaire. The interviews were then conducted with the close supervision of the researcher.

2.2 Secondary Data Collection

In addition to primary data collection, secondary data were collected from different sources. The data collected from the secondary sources include necessary documents, studies and other useful written materials needed for the study. Organizations contacted during the survey period were Ministry of Water Resources Development, Tigray Water and Energy Resource Development Bureau, Relief Society of Tigray, Woreda Water Resource development office, Tigray Cooperative and Marketing Agency.

2.3 Data Analysis

Both qualitative assessment and descriptive analysis techniques were used for data analysis. The data generated through household interview was analyzed by employing the computer Software known as statistical package for social science (SPSS)-*IBM SPSS Statistics-version 20*. The descriptive statistical methods such as frequency, percentage, mean, and standard deviation were used for analyzing the data generated through household focus group interviews.

2.4 Limitations of the Study

The following conditions can be considered as a limitation factors during field stay for data collection.

- The fact that this research was conducted in the specified period obliged the researcher to limit the sample population to sixty households who have access to irrigation facilities in both study sites. As compared to the number of households (463 households) who have access to irrigation facilities in the selected study area, limitation of the sample households to 60 may affect the degree of representation.

- Weak recording system of WUAs, Development Agents, and Raya-Azebo District Offices regarding the history of the constructed deep-well boreholes irrigation systems particularly lack of time series data on households who rented their irrigable land to second party;

- Problem of getting time series data since farmers' ability to recall was not strong.

2.5 Organization of the Paper

The paper is organized under six chapters. The first chapter includes background information statement of the problem, research question and significance of the study. Chapter two deal with the methodology of the study. Chapter three gives theoretical overview on smallholders' irrigation development. Chapter four deal with the description of the study area. Chapter five elaborates survey findings and discusses the results. Finally, chapter six gives conclusion and presents recommendations.

CHAPTER THREE: REVIEW OF LITRATURE

3.1 Definition of terminology and concept

3.1.1 Concepts and Definition of Food Security

Food security is defined as "access by all people at all times to sufficient food for an active and healthy life" (World Bank, 1986). The USAID (1992) defines food security as: "when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life." Food security includes at a minimum: the availability of nutritionally adequate and safe foods, and assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).

Three conditions must thus be satisfied to ensure food security: food must be available through domestic production and imports; food must be accessible or people must have adequate resources to acquire the appropriate foods; and food must be utilized in conjunction with adequate water, sanitation and health to meet nutritional needs; often, however, food security is discussed with reference to grains only. This can be misleading especially for societies (example pastoral societies) that are primarily dependent on sources of food other than grains. In fact, livestock have a very important role in achieving food security in Sub-Saharan Africa (SSA) (Ehui et al., 1998; Ehui, 1999).

Generally, available literature on food security revealed the definition of food security in terms of access by all household members at all times as central core being other condition also deemed necessary for healthy life. Food security can be explained as access of food by all people to the required dietary intake through various means. It touches the supply in terms of availability and capacity of people to obtain sufficient amount through their own ways.

3.1.2 Definition and Concept of irrigation

It is a well-established fact that water is the greatest source of humanity. It not only helps in survival but also helps in making life comfortable and luxurious. Besides various other uses of water, the largest use of water in the world is for irrigating land. Irrigation in fact is nothing but is a continuous and reliable water supply to different crops in accordance with their water requirement. When sufficient and timely water is not available to the crops, they fade away resulting in lesser yields (Garg, 1989).

The basic problem of water distribution in the world is the temporal and spatial differences that exist in the supply and demand of water. The general solution of this problem lies in adjusting water supply and demand so that the demand will always be smaller than or equal to supply (Taffa, undated).

The primary goal of irrigation, from farmer's perspective, is to deliver the volume and quality water required by plants, throughout a season, to optimize plant growth and crop production (Wichelns, 2000). Small and Svendsen, as it was cited in Wichelns (2000), define irrigation as “human intervention to modify the spatial or temporal distribution of water, and to manipulate all or part of this water for the production of agricultural crops".

Chamber (1988) suggested that from a farmer's perspective, good irrigation service involves the delivery of "an adequate, convenient, predictable and timely water supply for preferred framing practices." These perspectives of irrigation goals and performance are used to define the concept of irrigation from farmer's viewpoint. Irrigation success considers the degree to which water volume and quality, and the time of irrigation events match the requirements of plant throughout the season. Perfect success occurs when the volume, quality, and timing of water deliveries would generate maximum crop yield, given that non-irrigation inputs are not limiting. Actual yield will be less than maximum yield when irrigation success is less than perfect. Farmers attempting to maximize net revenue, subject to resource constraints, will select irrigation inputs to achieve a desired level of irrigation success (Wichelns, 2000).

It can therefore, be concluded that if full irrigation facilities are not developed, reduced crop yield shall be obtained and if sufficient grains are not available, virtually the entire progress of the humanity shall be hampered. In light of these facts, it can be easily emphasized that irrigation is the must, at least in tropical or sub-tropical countries. Irrigation may, therefore, be defined as the science of artificial application of water to the land, in accordance with the crop requirements throughout the crop period for full-fledged nourishment of the crops (Garg, 1989).

3.2 Theoretical Review

3.2.1. Irrigation development-historical perspective

Many literatures narrated that irrigation is an old human activity and been practiced in some parts of the world for several thousand years. According to

Zewdie et al. (2007), irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. Particularly, India and Far East have grown rice using irrigation nearly for 5000 years. Rice has been grown under irrigation in India and Far East for nearly 5000 years. Similarly, the Nile valley in Egypt and the plain of Tigris and Euphrates in Iraq were under irrigation for 4000 years (Peter, 1979).

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

However, several literatures pointed that irrigation techniques are various and in few cases complex depending on the topography and other compelling technical and technological factors. Some of these techniques include flooding, furrow irrigation, sprinkler irrigation and drip irrigation. In flooding method of irrigation water covers the entire surface of the field to be irrigated, while in furrow irrigation, only one fifth to one half of the land surface is wetted by water, it therefore results in less evaporation. Sprinkler irrigation is a method whereby the water is applied to the soil in the form of a spray through a network of pipes and pumps. It is a kind of artificial rain and gives very good results in terms of fulfilling the normal requirements of the plant and uniform distribution of water. Drip irrigation is the latest field of irrigation technique and is meant for adoption at places where there exists acute scarcity of irrigation water. In this method water is slowly and directly applied to the root zone of the plants, thereby minimizing the losses by evaporation (Garg, 1989).

3.2.2. Irrigation Development in Ethiopia

Ethiopia has a long history of traditional irrigation systems, especially in some parts of the country like Konso. The country's irrigation potential is estimated to be 4.5 million hectares of irrigable land, of which between 160 –190 thousand hectares (5-10%) is estimated to be currently irrigated (Gebremedhin and Peden, 2002). About 65,000 hectares of land is operated by 359,000 farmers under traditional small scale irrigation in Ethiopia (MoWR, 1997). Per capita irrigated area is also estimated at about 35 m^2, compared with the world average of 450 m^2. About 352 thousand hectares of land is said to be irrigable using small–scale irrigation schemes (Gebremedhin and Peden, 2002).

Despite the long history of traditional irrigation in Ethiopia, modern irrigation is recent phenomenon in Ethiopia. It was during the imperial regime that Ethiopia started to develop modern irrigation schemes and such interventions mostly concentrate in the Awash valley. At the beginning of 1970's, about 100 thousand hectares of land was estimated to be under modern irrigation. During the imperial regime, the main objective of irrigation was to provide industrial crops to the growing agro-industries in the country, many of which were controlled by foreign interests, and to increase export earnings (Gebemedhin and Pedon, 2002).

After the fall of the imperial regime, the Derg regime enacted new Land Proclamation in 1975 which nationalized all large–scale irrigation schemes and placed under the responsibility of the Ministry of State Farms. Most of the landlord based small scale irrigation schemes also fell into the hands of producer-cooperatives (FAO, 1995c). The military government also gave much emphasis to large-scale irrigation schemes which were used by the nationalized agro-industrial and agricultural enterprises. In all these times the importance of small-scale irrigation was marginalized. It was after the devastating famine of 1984/85 that the government showed some interest on small-scale irrigation system. In response to these catastrophic droughts Irrigation Development Department (IDD) was established in the Ministry of Agriculture (MOA), a body entrusted with the development of small-scale irrigation projects for the benefit of peasant farmers, signaled a new approach to water development by the military government. However, progress was slow. From the mid- 1980s to 1991, IDD was able to construct some 35 small schemes, of which nearly one-third was formerly traditional schemes used by peasants (MoA, 1993; Desalegn, 1999).

With the change of government in 1991, when EPRDF took power, the focus on large-scale irrigation development and the neglect of small-scale schemes was reversed. The EPRDF government has given more attention to the development of small-scale irrigation schemes and improvement of farmer–managed traditional schemes at the forefront of its water development policy. The establishment of MoWR (Ministry of Water Resources) enables the unification of public agency for water resources development. Irrigation Development Department (IDD) was dissolved in 1994 and was replaced by Regional Commissions for Sustainable Agriculture and Environment Rehabilitation (Co-SAERS) in a number of regions. The primary mandate of the Co-SAERs also remained rather technical–oriented, with inadequate attention accorded to policy, socio-economic and institutional issues. However, there have been significant improvements in beneficiary participation compared with during the military regime.

In contrast to the above realities, Ethiopia has a high potential for irrigated agriculture. It is endowed with abundant water resources; lakes covering 7400 square kilometers, 10 major rivers, and other water bodies, which are expected to provide extensive potentials for irrigation and fish farming (Mangistu, 2000).

Although, water resource potential is said to be abundant in Ethiopia, it is clear that even by the low standard of African countries, Ethiopia's use of its water resources is very limited. Less than 5 percent of the country's irrigable land is now under irrigation. In contrast, according to FAO (1987), the three countries in Sub-Saharan Africa with the largest irrigation are Sudan (2.2 million ha), Madagascar (1.00 million ha) and Nigeria (0.9 million ha). In Sudan, 14 percent of the country's cropped land is under irrigation, while in Madagascar, the figure is 32 percent. In contrast, almost all the cropped land in Egypt is under irrigation. For comparison, irrigation in Ethiopia covers less than three percent of the country's cropped land. Assuming that all the irrigated land is utilized to produce food crops, the contribution of irrigation to the production of food would not be significant when compared to the area under rain-fed (Desalegn, 1999). Therefore, a rational management and development of water resources is required to effectively and efficiently utilize water resources to achieve food self-sufficiency and food security. Thus it is essential to develop a small-scale irrigation system. Harnessing some of the sizable rivers can produce some medium-to small-sized irrigation projects (Taffa, undated).

Recently, however, the Ethiopian government has realized the need to massively invest in developing different irrigation schemes that best suit each localities best endowment and accordingly is implementing huge irrigation projects in many parts of the country that would hopefully would bring major improvement in ensuring food security both at national and household level.

3.2.3. Irrigation and poverty nexus

Irrigation has been seen by many governments and NGO's of developing country as a means of attaining food self-sufficiency particularly in drought prone areas. The prime objective of many irrigation projects is to increase frequency of harvest, enhance productivity and production, and increase household income on sustainable base thereby reduces poverty (Sadoulet and de Janvry, 1995).

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

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

In consonant with the above argument, Rosegrant, et al, (2002) and FAO (1986:20) argued that there has been significant cutbacks in rain-fed agricultural production due to frequent occurrences of drought and erratic rainfall especially in the Sub-Sahara African countries. In Sub-Sahara Africa, 196 million people are undernourished (FAO 2002: Woldeab, 2003). Governments of SSA countries have considered irrigation, as an attractive solution for removing the food insecurity problem and ameliorating the impact of droughts (Woldeab, 2003).

The linkage between irrigation and food security is quite an established fact in the sense that increased agricultural production through application of irrigation can diminish rural poverty. At the level of the national economy, increased agricultural production can substitute for imports and generate exports. Moreover, increased agricultural production can also reduce the cost of food grain procurement. With livelihood thinking irrigation is assessed in terms of the adequate and secure livelihoods it generates and sustains, putting anti-poverty effect, and people, before per se. An adequate and secure livelihood can be defined here as a level of assets and stocks and flows of food and cash which provides physical and social well-being for household and protection against impoverishment. This applies to all members of household and especially to women, who are most deprived (Chamber, 1988).

Thus, one can safely argue that irrigation is a major driving factor of the increase in rural household income through agricultural growth. Many studies in the subject strongly attest that irrigation expansion should receive special attention in the main policy intervention to alleviate rural poverty. According to Lipton et al. (2004) as cited by Haile (2008) the four main inter-related mechanisms to reduce poverty are:

- Irrigation increase agricultural production and income, as it facilitates the intensity of cultivation that leads to an increase in agricultural productivity and greater returns from farming for households with access.
- Irrigation protects from the risk of crop loss due to erratic, unreliable or insufficient rainwater supplies.

- Irrigation enhances the use of yield-enhancing farm inputs. The uses of such farm inputs improve the agricultural production and income.

- Irrigation creates additional employment. Household and/or laborers are engaged in the irrigation farming that helps to increase the labor productivity during the dry periods, farm off-season.

3.2.4. Small scale irrigation management

Molligna (2003) quoting Uphoff states that irrigation management activities have both technical and social dimensions. These include control structure activities (design, construction, operation and maintenance), water use activities (acquisition, allocation, distribution and drainage), and organizational activities (decision making, resource mobilization, communication and conflict management).

Further, Mollinga (2003) quoting Hubert classifies irrigation management functions into four types viz. planning, organizing, leading and controlling. These tasks and activities should be properly coordinated and managed in irrigation systems.

However, Hunt as cited in Molligna (2003) attached high importance to the water control aspect of the irrigation management dimensions. According to Hunt as cited in Molligna 2003, in irrigation management, water control is crucial. It refers to the managerial control of water distribution and organizational processes in the irrigation system (Hunt 1990:144 in Mollinga 203). Irrigation management or water control is thus the regulation and control of human behavior; implying social relation of power and competition (Mollinga 2003). Effective water control in irrigation management is a function of several factors including physical, technical, socioeconomic, organizational, political, cultural and complex institutional factors (Lawdermilk 1990: Mollinga 2003:35).

It was however Byrnes (1992) who provided detail analysis of the management function of the three components of the irrigation management as narrated below:

According to Byrnes (1992), management activities focusing on the provision of water to crops in an adequate and timely manner includes acquisition, allocation, distribution and drainage. Acquisition is the first management activity concerning the acquisition of water from surface or subsurface sources, either by creating and operating physical structure such as dams' weirs or wells or by actions to obtain some share of an existing supply. Allocation refers to the assignment of rights to users thereby determining who shall have access to water. Distribution refers to the physical process of taking the water from a source and dividing it among users at certain places, in certain amounts, and at certain times. Drainage is important where excess water must be removed (Byrnes, 1992).

Byrnes (1992) further explains the management functions within the control structure activities. According to Byrnes, management activities focusing on the structures required for water control include design, construction, operation and maintenance. Design involves the design of dams' diversions or well to acquire water, of systems of rules to allocate it, of channels and gates to distribute it and of drains to remove it. Construction involves the construction of the structures to acquire, distribute and remove water, or implementation of rules that allocate it.

Operation refers to the operation of the structures that acquire, allocate, distribute or remove water according to some determined plan of allocation. Maintenance is the final control structure activity. This provides for the continued and efficient acquisition, allocation, distribution and drainage (ibid).

The management functions in organizational activities focused on the organization of efforts to manage the structures that control irrigation water include resource mobilization, conflict resolution, communication and decision-making. The activity of resource mobilization entails marshaling management and utilization of funds, manpower, materials, information or other inputs needed to control water through structures or to undertake various organizational tasks (ibid).

The activity of communication entails conveying information about decisions made, resource requirements etc. to farmer or any other persons involved in irrigation managements. The activity of decision making entails the processes including planning involved in making decision about the design, construction, operation or maintenance of structures; acquisition, allocation, distribution or drainage of water or the organization deals with these activities (ibid).

It was assumed that devolving management responsibility with or without some form of scheme ownership to the irrigating farmers, improves scheme performance, water distribution and productivity, while saving public resources for agencies to carry out such tasks (IWMI, 2005).

Merrey et al. (2002) also indicate that irrigation management transfer helps reduce the government's recurrent expenditures for irrigation. Irrigation systems in many developing countries were established with substantial financial contribution from international donors. It was assumed that the government and or water users would be able to incur the cost of operation and maintenance (O & M) of the systems made possible by enhanced financial gains from improvement in productivity levels of irrigated agriculture.

Groenfeldt (1997) quoting Ostrom (1995) states that, the reason that reasonable observers view irrigation management transfer as necessary have to do with both empirical assessment and institutional theory. On the empirical side, irrigation infrastructure in many countries is deteriorating due to the proximate causes of budget constraint in the administering agency, demoralized staff, corruption which leads to inferior quality construction and inappropriate initial designs. Theory suggests that it could hardly be otherwise. The incentives facing irrigation agency staff as well as aid professionals in international donor agencies are perverse.

3.3 Empirical Review

3.3.1 Empirical evidence of irrigation for household food security-Global perspective

The following empirical studies relate to this study either in the methodology applied or the issues discussed. The studies deal mainly on the impact of irrigation schemes on improving income, agricultural productivity and poverty reductions. Moreover, it also highlights the main constraints facing small scale irrigation operators not to generate the maximum benefit out of the constructed irrigation schemes.

The literature that examines the impact of irrigation on agricultural performance and poverty alleviation shows mixed argument. A study made by Huang,Q. et al (2005) on agricultural production, productivity and income growth cannot identify a positive effect of investment on irrigation in China. Fan et al (2000) illustrates that government expenditure on irrigation had only a modest impact on agricultural production growth and even less on rural poverty and inequality. Furthermore, Jin et al (2002) did not find a link between irrigation and total factor productivity growth of any major crop (rice, wheat or maize) in China between 1981 and 1995. Rosegrant and Evenson (1992) were also unable to establish a positive link between irrigation investment and productivity in India. Evidence from Gujarat (India) suggests that access to irrigation is a sufficient condition, but not necessary condition for poverty reduction T. Shah and O P Singh, (at website:http://www.iwmi.org/iwmi-tata). Some of the most rapidly growing areas in Gujarat, which are reducing their below poverty line ratio (BPLR) have little or no irrigation. In contrast, some areas with high irrigation have high BPLR. In general T. Shah and O P Singh, (at website:http://www.iwmi.org/iwmi-tata) shows that areas with high irrigation ratio commonly have low BLPR; and it is equally common for areas with low irrigation to have high BPLR. But, a much larger number of communities have lower irrigation as well as low BPLR, which suggest that irrigation is not the only means to reduce rural poverty.

As regard to the findings of T. Shah and O P Singh, (at website:http://www.iwmi.org/iwmi-tata), there cannot be disagreement that irrigation is not the only means to reduce poverty. However, the basic question here is that why areas with high irrigation have high poverty as compared to areas with no irrigation? Some of the possible reasons suggested in the literature are: irrigation benefits within command areas may approach a zero-sum game over long run and that areas with intensive irrigation may attract poverty from the surrounding in the form of migration, which may overshadow its impact.

On the other hand, T. Shah and O P Singh, (at website:http://www.iwmi.org/iwmi-tata) considered irrigation as a major catalyst for agricultural growth. Irrigation is also a precondition to the adoption of the green revolution technology of high yielding seeds and chemical fertilizer. There are numerous studies that highlighted the positive impact of irrigation on the small holder economy and on crop yields, cropping patterns, cropping intensity, labour use, farm wage rates and gross and net incomes from irrigated farming as compared to rain fed farming, thus access to irrigation has strong impact on poverty reduction.

In line with the above argument, Hossain (2000) was able to establish a positive impact of irrigation on rural household income in Philippines and Bangladesh. A study by Hussain et al. (2004) confirms that, access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities; both on farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas. Hussain et al. (2004) identified five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare.

China's success in achieving food self-sufficiency took place in the 1960s and 1970s when China's government made massive investment in irrigation infrastructure suggested that irrigation played a key role in rural development (Huang, et al, 2005). Size of irrigated land per capita is strongly correlated with annual cropping income compared to households without irrigated land. Annual per capita cropping income in China is 40 percent higher in households that have irrigated land holdings up to 0.067 hectare per capita. Interventions in irrigated agriculture have yielded immense benefits in Asia. Cereal production has more than doubled, between 1970 and 1995, from 300 million tons to 650 million tons. This remarkable growth in food production was largely attributed to the growth in irrigated agriculture, coupled with the use of high-yielding varieties and fertilizer. Thus, irrigation is believed to have benefited the population by providing more food at reduced prices (Hussain I., and Hanjra M. A., 2004). Cropping income per capita continues to increase as irrigated land per capita increases (Huang, et al, 2005). Furthermore, it shows that as irrigated land per capita increases, cropping income becomes a major source of household income, however, total income per capita does not show the same monotonically increasing relationship with irrigated land areas (ibid, 2005).

The success of irrigation in Africa has been an issue of debate because of its disappointing performance in many cases (FAO, 1986: Webb, P., 1991 and Woldeab, 2003).

As regards positive impacts of irrigation schemes (SSIS), it is argued that about 75% of all SSA countries irrigation projects achieved or exceeded economic return though they are not operating at full capacity (Shawki and Maigne (1990).

FAO (1987: FAO, 2000) pointed out that many SSA countries have realized the critical role of irrigation in food production. Irrigated maize yields three times as much as rain-fed during drought years in Zimbabwe (Meinzen: Webb, P. et al, 1994).

FAO (2000) found out that irrigation helped to increase agricultural productivity of a given land through increased intensification in Africa such as Zimbabwe.

Findings of FAO (2000) proved that choices of crop types could be facilitated by irrigation and increase food variety and availability. Furthermore, FAO (1997 b: Nigussie, 2002: 22) and Meinzen-Dick et al (1993: Nigussie, 2002: 22) reported that 72% of farmers could secure better food production through the use of irrigated land in Zimbabwe. Moreover, study by Webb (1991) of an irrigation scheme in Gambia showed that irrigation provided the chance for increasing income that was translated into increased expenditure, investment in productive and household assets, saving and trade.

Contrary to the above, there are arguments against the positive impacts of irrigation in Africa. Woldeab (2003) has noted that African countries challenged by drought and famine have been considering irrigation as a drought mitigation strategy; with little attention to sustainability issues though it is one of the qualifications of SSI for achieving the food security goal. Desalegn (1999) examined that many drought prone countries of Africa, whose population cannot be adequately supported by rain-fed agriculture alone, expanded irrigation schemes to promote food security. Nevertheless, many of these water projects were performing poorly and unable to meet their objectives.

FAO (2000) as cited in Nigussie, 2002 indicated that most new smallholder irrigation schemes in the southern Africa region could not cover the cost of development and they have negligible impact on household food security.

There are a number of constraints that have been responsible for a slow rate of development and underperformance of irrigation. Field research has highlighted substantial shortcomings in management (operation and maintenance), equity, cost recovery and agricultural productivity (Odi, 1995). A review of project experience by FAO (1986) and Woldeab (2003: Shawki and Maigne, 1990)) make clear that institutional, social, policy and economic problems tended to be more common constraints to the exploitation of small-scale irrigation schemes in Sub-Sahara Africa (SSA). To add to this, Webb, P. (1991) found out that one of the reasons for the failure and unsustainability of small-scale irrigation projects in Gambia has been institutional and management deficiencies. But few of the institutions responsible for irrigation are adequately structured and lack of qualified personnel is another cause of poor management performance irrigation systems in Africa (FAO, 1986: 53).

According to ODI (1995), the factors that account for under performance of irrigation include, among others:

1. Poor system management and service provision, and
2. Poor understanding of farmer priorities or and inadequate markets for produce (ibid);
3. Lack of clear and sustainable water rights accorded to users, at on individual or group level;
4. Lack of clear and recognized responsibilities and authority vested in the managing organizations;
5. Lack of transparent accountability of, and supporting incentives for, the managing entities.

3.3.2 Empirical evidence on Irrigation Management in Ethiopia

A study by Shimelis (2006) assessed the institutional and management practices of small scale irrigation systems in Ethiopia. He took the case of two small scale irrigation systems in eastern Oromiya: Gibe Lemu and Gambela Terra. A total of 65 sample households were selected from 216 households. Interview with key informants, Water Users Association committee members and different experts were made. Focus group discussion was also held.

The result shows that the irrigation systems were poorly managed in terms of water allocation and distribution, conflict management and system maintenance, because of lack of well-established organizational and institutional conditions.

The water user associations are not well organized and found to be weak to run the irrigation systems. Users have problematic social relation. Clearly defined and well-enforced land and water rights are non-existent at the operational level. Regarding technical resources such as improved seed that is adaptive to the situation of irrigation, labor and knowledge of irrigated agriculture (extension service and capacity building for irrigators) have not been met in the two irrigation systems.

Checkol and Alamirew (2007) conducted a study on technical and institutional evaluation of Geray irrigation scheme in west Gojjam zone, Amhara region, Ethiopia. The technical evaluation was made by looking into the selected performance indicators such as conveyance efficiency, application efficiency7, water delivery performance8 and maintenance indicators. The result of the study showed that the main and tertiary canals conveyance efficiencies were 92% and 82%, respectively. Many of the secondary9 and tertiary canals are poorly maintained and many of the structures are dysfunctional. Moreover, application efficiency monitored on three farmers' plot located at different ends of a given secondary canal ranged 44 % up to 57%. Water delivery performance was only 71% implying a very substantial reduction from design of the canal capacity. Besides, maintenance indicator evaluated in terms of water level charge10 (31.9%) and effectiveness of infrastructures11 (67%) shows that the scheme management was in a very poor shape.

The result also depicts that the 47% of the land initially planned is currently under irrigation while there was no change in the water supply indicating that the sustainability of the scheme is in doubt. The scheme has been managed by Water

Users Association for four years, despite the fact that it was constructed 27 years ago. Moreover, the study shows that the overall performance of the Water Users Association in terms of managing the schemes was very poor. Furthermore, support services rendered to the beneficiaries were minimal. There were very few indicators that production was market oriented.Ironically, farmers didn't recognize market as their problem. Conflict resolution has been the duty of the *Kebeles* Council and Water Users Association has no legal authority to enforce its by-laws.

Salilih (2007) employed both qualitative and quantitative approach, to assess the contribution of irrigation on household food security and irrigation management and problems associated with it in the case of Zingni and Fetam small-scale irrigation schemes in blue Nile basin of Amahara national regional state. The findings of the study revealed that irrigation contribution on minimizing household's socio-economic poverty significantly vary from one irrigation scheme to another. Its contribution also vary across irrigation systems depending on the physical structures of the scheme, amount of irrigation water, plot size, availability of agricultural inputs, management qualities and educational status of individual farmers to accept new ideas. For instance, 83.3 % and 42% respondents in Wonjella (Fetam) and Deninatquashta Kebeles (Zingni) ,respectively confirmed that improved irrigation system benefited them to minimize households' socioeconomic poverty. However, the degree of poverty is still high in Deninatquashta than in Wonejella Kebele and socio-economic and institutional problems are commonly much higher among female-headed households especially those households that have no close relatives and farmers who are disabled and aged. The two modern schemes are constrained by socio-cultural and technical problems. With the presence of these problems it is very different to generalize that irrigation system can reduce household socio-economic and institutional poverty.

Finally, the author forwarded conclusion and recommendation based on the findings, farmers participation from inception to completion of irrigation projects should be a prerequisite for the sustainability of irrigation schemes, equitability and security in access and right to resource such as land, water and credit. In addition, training on irrigation water management contribute to break rural households' socio-economic poverty and help mainstreaming of gender in each irrigation management activities.

Gebremedhin and Pender (2002) analyzed the productivity of irrigation in the highlands of Tigray in 1998/99. The survey was based on 50 communities and 100 villages. The result showed that irrigation was found to increase the intensity of input use, especially labor, oxen, improved seeds and fertilizer. Controlling for other factors, use of manure or compost was about 50% more likely on irrigated plots than on rain-fed plots. By increasing such inputs, irrigation contributed to increase crop production. The predicted impact of irrigation was 18% increase in crop production relative to rain-fed field plots. On the contrary, the impact of irrigation on the productivity of land management practices was statistically insignificant.

In the same way, another survey was done in Amhara highlands of Ethiopia. Irrigation was associated with improved technologies such as fertilizer and manure, and other inputs like improved seeds and pesticides, labor and draft power. However, the impact of irrigation on the productivity of farming practices was insignificant (after controlling other factors) (Benin et al. 2002).

Gebremedhin and Pender (2002) recommended that in both the highlands of Amhara and Tigray, the reason for failure of irrigation to improve productivity of farming practices needs further careful research on the technical, institutional, governance and managerial aspects of irrigation. In addition, they also suggested that such an investigation can give important guidance for policy and institution intervention to increase the impact of irrigation on productivity and income.

CHAPTER FOUR: OVERVIEW OF THE STUDY AREA

4.1 Physical and demographic features

The study area (Raya-Azebo District) is part and parcel of the Raya Valley, which comprises the total area of Raya Azebo and Alamata Woredas and some eastern high lands of Endamekoni and Ofla Woredas. Geographically, the district is located in the southern zone; between 120 18'15''and 120 38'15'' and it is about 112Km far from Mekelle city (REST 1996). It is bounded to the south by Alamata District, to the east by the Afar region, to the northwest Hintalo wajirat and to the west Endamekhoni District. The average elevation of the study area is 1700 masl with a range of 1400-1900 masl (Figures 1: Map of Study Area-Apendix 1).

The total population of the district is about 136,039 (CSA, 2007) and of which 88% or 119,988 of the districts' population live in rural areas. (ibid).

Topographically the Raya Valley is divided in to two major zones: low land areas with an altitude less than 1500 m.a.s.l which mostly covers large part of the central part of the valley; and the high land areas having altitude above 1500 m.a.s.l which covers the western and eastern edges of the valley (ibid). According to the moisture index criteria provided by REST, the Raya Valley area is classified as dry climates of semi-arid and arid types (REST 1997: 4).

The principal feature of rainfall in the area is seasonal, poor distribution and variability from year to year. In essence, the Raya Valley has a bimodal rainfall pattern. Though diminishing from time to time, the area experiences a short rainy season locally known as *Belg* which runs from February to April followed by the main rain season called *Kiremt* which runs from June to early September (REST 1997). Eastern and western highland of the valley experience better rainfall. For instance the Chercher highlands get average rainfall of 620 mm while the Maichew highlands get up to 775 mm of rainfall annually. The high fluctuation and unreliability becomes most common in the lowland valley of Mekoni and Alamata areas. The average annual rainfall collected from Mekoni and Alamata meteorological stations show that it is 486 and 693 mm annually respectively (ibid).

4.2 Socio-economic characteristics

4.2.1 Agriculture and Land Use

The study area has an estimated total land area of 61,987 ha out of which total cultivated land comprises about 36, 577 ha. The remaining 5774 ha, 13,537 ha and 6099 ha is allocated for communal grazing, community forest and other miscellaneous purposes respectively (RVDP, 1997).

Like the rest of the region, agriculture in the Raya Valley is dominated mainly by smallholders. Farming is done by the use of traditional bullock drawn plough pulled by draught animals and simple hand tools. Crop production is conducted mainly under rain-fed and traditional flood diversion to supplement water requirement of crops (REST 1996).

The main crops grown in the area before the modern irrigation system were Teff, Sorghum, Maize, and other cereals from July through November. Due to the low rainfall amount and high rate of evaporation and transpiration during the Belg rainy, there was no crop grown during this period i.e. farmers were producing once a year. But now, with the use of ground water since 2007/8, farmers are producing twice a year. In addition to the above cereals, cultivation of the most commercial crops in the country such as tomato, onion and pepper is possible during the dry season i.e. from March/April to June/July.

Most farmers in the Raya Valley pursue a strategy of mixed farming (crop and livestock production). Depending on the rainfall available in a specific season households produce sorghum, maize, barely, teff, and dekeko. In good rainy season, farmers are able to produce up to 30-40 quintal of sorghum per hectare. The area is also known for rearing livestock such as oxen, cows, camel, and donkey (ibid).

The Raya Valley is an agriculturally potential area for crop production, livestock grazing and browsing. Especially the low land areas of the valley are characterized with deep and fertile soil which is suitable for agricultural production. The size of land holding in the Raya Valley area varies from the mountainous part to the low land areas. The average land holding in the highlands of Mekoni and Ofla ranges from 0.51-1 ha while in the low land areas of Mekoni ranges from 1.01- 1.5 ha. This indicates that there is relatively better land holding size in the low land areas of the valley (COTWRD 2004).

4.2.2 Water Resource

The river systems in the Raya Valley drain to the Denakil (Afar) through the Hum Sheet (Sulula River). The entire tributary rives in the valley flows to the Sulula River situated at the centre of the valley and drains south wards to join other rivers from Amhara region the Zoble highlands and drain together to the Denakil depression in the Afar region (REST 1997). The Raya Valley area is therefore part of the Denakil River basin which has a total catchment area of 74002 km^3 from

Tigray, Amhara and Afar regional states. This river basin has a total mean annual flow of about 0.86 Bm^3 per year (Awulachew, et al, 2007).

The Raya Valley area has considerable surface water potential. In addition to the limited rainfall, the Raya Valley benefits from seasonal flow of more than 15 streams and rivers (ibid).

These streams and rivers come from the western and eastern highlands produce about 170Mm^3 water every year (REST 1996, cited in Haile 2009).

The lowland area of the Raya Valley has potential for exploitable ground water resource. According to the REST (1996: 16) study report the area has about 4233Mm^3 reserve ground water resources out of which 100Mm3 is exploitable annually. The ground water resource with good quality for irrigation can be obtained starting from depth of 60 m in the north to 20 m depth in the south of the valley. Both the surface and ground water resource of the Raya Valley are potential to utilize the relatively abundant and fertile agricultural land for irrigated agriculture.

4.2.3 Irrigation Practices

According to COTWRD (2005) moisture stress is the major limiting factor for crop production in the Raya Valley. Rain fall is inadequate and erratic in distribution. In the low land areas of the valley it is difficult to produce crops such as the local long season cultivar of sorghum variety with the limited amount of rainfall. As a result farmers in the lowland areas of the Raya Valley are used to traditionally harvest flood water that comes from the neighboring highland areas with relatively better rainfall to supplement their crops.

According to REST (1997: Haile, 2009) there are two types of traditional irrigation practices in the Raya Valley area. These are traditional small scale irrigation and spate irrigation. The traditional small scale irrigation is practiced in few rivers which has year round flow. In such kind of irrigation the major crop produced by farmers is *Chat* and some cash crops. On the other hand farmers in the foot hills of the valley attempt to overcome the moisture stress they face by traditionally diverting flood water that comes from the nearby hills and mountains using temporary traditional diversion structures. This type of supplementary irrigation known as spate irrigation has been in practice in the area for generations. In this case using the traditional spate irrigation systems farmers in the Raya Valley supplement up to 21250 ha of land and thereby obtain relatively higher yield (REST 1997: Haile, 2009).

Ground water is traditionally extracted with shallow wells which irrigate small areas (about 100 m2). Since the area was targeted for irrigated agricultural development, the Federal and Regional Government supported the development of 18 deep wells in nine Peasant Associations. To date, 16 of the deep wells are functional in nine Tabias with potential command area of 2225 hectares benefiting 1385 HHs. The constructed deep well irrigation schemes are modern and operates through electric power with drip irrigation accessories fitted in all the command area that operates through pump irrigation system.

Wargba and Kara-Adishabo are among the nine *tabias* in the district who have access to modern deep well irrigation system. In Wargba a total of four deep wells have been constructed with irrigation potential of 143 hectares of land benefiting 319 households. Similarly, five deep wells have been constructed in Kara-

Adishabo with command irrigation area of 142 hectares benefiting 314 households (RoWRD, 2012). Table 3.1 below depicts list of boreholes in the sampled study area and their irrigation potential.

Table 3.1: List of boreholes in sampled study area and boreholes sampled for the study

S/N	***Name of Sampled Tabias (Location)***	***Number of boreholes in study location***			***Sampled boreholes in study location***		
		Name of boreholes	***Command Area (Ha)***	***HHs who have access to the irrigation system***	***Name of Boreholes***	***Command Area (Ha)***	***HHs who have access to the irrigation system***
1	**Kara**	Kara-1	42	120	Kara-1	42	120
		Kara-2	18	54	Kara-2	18	54
		Kara-3	17	51	Kara-3	17	51
		Ana	36	46			
		Fire-limat	29	43			
		Sub Total:	**142**	**314**	**Sub Total**	**77**	**225**
2	**Wargba**	Lemlem-Wargba	44	97	Lemlem-Wargba	44	97
		Selam-wargba	39	86	Selam-wargba	39	86
		Birhan-Adimokeni	22	50	Birhan-Adimokeni	22	50
		Awet-Wargba	38	86			
		Sub Total:	**143**	**319**	**Sub Total**	**105**	**233**

CHAPTER FIVE: SURVEY RESULT AND DISCUSSIONS

5.1 Socio-economic characteristics of the respondents

Table 5.1 shows a summary of the demographic and other characteristics of households in the study areas namely Kara and Wargba irrigation schemes. Of the 60 households interviewed in the two irrigation systems, 83.3% were headed by males and 16.66% were headed by females. Age of the household head, 90% in Kara and 87% in Wargba was in the range of 26- 65 years. Regarding level of education, the majority of the interviewed households, 50% in Kara and 53% in Wargba, were illiterate. Occupation of the farmers in the command area of both irrigation systems is based on smallholder mixed crop-livestock farming.

Table 5.1: Socio-economic characteristics of the respondents

Characteristics	%age of households			
	Kara (N=30)		Wargba (N=30)	
	Count	%	Count	%
Age of head:				
Below 15	0	0	0	0
15-25	1	3	4	13
26-65	27	90	26	87
Above 65	2	7	0	0
Level of education of the HH				
Illiterate	15	50	16	53
Read and write	9	30	7	23
Elementary	3	10	4	13
Junior secondary school	1	3	2	7
High school complete	2	7	1	3

Source: Survey Result

Table 5.2 below also depicts the occupations from which the surveyed households derive their means of livelihoods. The majority of the surveyed households have been engaged in three or all of the farming activities described in table 3.2. But very few farmers, 13.3% in Wargba reported to engage in off-farm activities (Table 5.2).

Table 5.2 Distribution of sample household by their occupation

Description	% of respondents giving the response	
	Kara (N=30)	Wargba (N=30)
Crop under rain fed	86.7	56.7
Crop production using irrigation	93.3	96.7
Livestock rearing	13.3	10
Off-farm activities	0	13.3
Others	0	3.3

Source: Survey result

In addition to crop production using rain and irrigation, livestock rearing is also an important economic activity in both irrigation systems. They rear cattle, sheep, goat, chicken and equines (table 5.3). The average number of cattle and chicken owned by the sample irrigators was higher in Wargba compared to Kara; which was 4.5 cattle and 4 chicken per household (table 5.3). But the average number of goat and sheep was relatively larger in Kara as compared to Wargba.

Table 5.3: Livestock ownership by type of animal

Type of Livestock	**Kara (N=30)**			**Wargba (N=30)**		
	Mean	**N**	**St. Dev**	**Mean**	**N**	**St. Dev**
Cattle	2.80	21	2.644	4.57	25	4.141
Sheep	1.63	8	3.337	0.37	5	1.033
Goat	0.13	1	.73	0	0	0
Donkey	0.10	1	0.548	0.03	1	0.183
Camel	0.47	2	1.943	0.57	3	2.176
Chicken	1.83	10	3.649	4.10	16	6.94

Source: Survey result

On the other hand, the survey result in table 5.4 indicates that irrigation users have more cattle, camel and chicken compared to non-irrigation users in both irrigation schemes while non-irrigation users reported to have higher number of sheep than their counterpart.

Table 5.4: Livestock ownership of Irrigation users and non-irrigation users

Description	*Irrigation users and non-users livestock ownership by type of livestock*						
	Statistics	***Cattle***	***Sheep***	***Goat***	***Donkey***	***Camel***	***Chicken***
Irrigation users (40)	Mean	4.0	1.0	0.1	0.1	0.8	3.1
	Std. Deviation	3.0	2.7	0.6	0.5	2.5	6.2
	Variance	8.8	7.5	0.4	0.3	6.1	38.8
	Sum	160	38	4	4	30	122
Non-Irrigation Users (20)	Mean	3.1	1.1	0.0	0.0	0.1	2.8
	Std. Deviation	4.5	2.1	0.0	0.0	0.2	4.3
	Variance	20.6	4.5	0.0	0.0	0.1	18.3
	Sum	61	22	0	0	1	56

Source: Survey result

Oxen are the main sources of draft power for cultivation in both irrigation systems (ROARD, 2012). Table 5.5 shows that 80% and 70% surveyed households in Wargba and Kara respectively reported having at least one ox. Besides, 70% of the surveyed households in Warba have a pair of oxen or above which is comparably higher than surveyed households in Kara in which only 54% of respondents reported to have a pair of oxen or above (table 5.5). On the other hand, the average ox ownership is found to be higher among non-users compared to irrigation users with higher variance implying that few non-irrigation users own higher number of oxen (Table 5.6). The survey finding, however, deviate from findings of studies in similar subject. However, in the context of this study non-users are those households who have access to irrigation but preferred to lease out their irrigable land for rental arrangement

Table 5.5: Ox ownership

Characteristics	%age of households			
	Kara (N=30)		Wargba (N=30)	
	Count	%	Count	%
Ox ownership status				
one ox only	5	17	3	10
more than a pair of oxen	2	7	7	23
a pair of oxen only	14	47	14	47
Have no oxen at all	9	30	6	20

Source: survey result

Table 5.6 Ox ownership among Irrigation users and non-users

Statistics	Irrigation users (N=40)	Non-users (N=20)
Mean	2.55	3.2
Std. Deviation	0.904	1.105
Variance	0.818	1.221

Source: survey result

The average round trip distance from the main asphalt road and the market place is different between the two irrigation systems. Irrigators in Kara have to walk longer hours than Wargba to access the nearest local market to sale their agricultural produces (Tables 5.7). It has however, been noted that there is all-weather road in both irrigation scheme operators and this is an important indicator for successful irrigation as argued by different scholars including Engel and Dillion (Engel, 1997; and Dillon, 1992).

With regard to availability of adequate labor force for operating the irrigation scheme, Table 5.8 shows that 53% of the interviewed households in both irrigation scheme stated that they haven't enough labor for irrigation farm operation (Table 5.8). The implication is that labor demands for irrigated agriculture is in conflict with the busy time of the majority of farmers in the irrigation systems and become an important cost item in the overall operation of the irrigation.

The average number of active labor per household was higher in households headed by males in both irrigation systems (Table 5.8). The number of rich households who expressed the opinion that they are endowed with adequate household labor for irrigated farming was the lowest in both irrigation systems compared with poor and middle income groups despite the fact that they were managing a larger area of irrigable plots.

Table 5.7: Average distance from the market and average number of household labor

Round trip distance (minutes)	Kara			Wargba		
	Mean	N	St. Dev	Mean	N	St. Dev
From the main road	13.73	30	9.082	18.67	30	10.499
From the market	3.72	30	6.929	1.9	30	0.548
No. of active HH labor	MHH	FHH	Total	MHH	FHH	Total
Mean	0.934	0.714	1.648	1.046	0.286	1.332
N	25	5	30	28	2	30
St. Dev	0.476	0.583	1.059	0.533	0.233	0.766

Source: Survey result

Table 5.8: Availability of enough labor force to operate the farm irrigation

Responses on availability of enough labor force to operate your irrigation farm	Name of irrigation system	Wealth status of respondents			Total	%
		Poor	Medium	Rich		
Yes	Kara	3	11	0	14	46.7
	Wargba	3	8	3	14	46.7
	Total	**6**	**19**	**3**	**28**	46.7
No	Kara	4	12		16	53.3
	Wargba	4	12		16	53.3
	Total	**8**	**24**		**32**	53.3

Source: survey result

5.2 Institutional/Organizational conditions of the irrigation system

5.2.1 Land tenure

5.2.1.1 Land use category and average landholding

The farmland in Kara and Wargba irrigation scheme is broadly categorized into rain-fed and irrigable lands. Reportedly, all or 100% of the sample households in both irrigation schemes possess their own farmland. The average total farmland and the average plot area allocated for rain fed agriculture was higher in Wargba compared to Kara (table 5.9). In Wargba, the sample households allocated a large part of their farmland for irrigation (an average of 0.79ha) (Table 5.9). In the same development, the survey outcome revealed that average land holding is higher for medium and rich households in both irrigation schemes while average farm under-irrigation is higher for better off households in Wargba compared to Kara.

However, from the focus group discussion, it has been learnt that allocation of total farm land to irrigation depends on the location of the farm land to the irrigation schemes. Reportedly, households whose farm land at nearest distance to the irrigation scheme will have more advantage to employ all the available farm land under irrigation if other cost factors for operating the irrigation scheme are assumed constant.

Table 5.9: Average landholding by type of use and wealth status

Description	Irrigation system	Wealth status	Statistics	
			Mean	N
Total Farm Land	Kara	Poor	0.57	7
		Medium	0.64	23
		Rich	0	0
		Total	0.61	30
	Wargba	Poor	0.64	7
		Medium	1.13	20
		Rich	1.83	3
		Total	1.2	30
Irrigable farm land	Kara	Poor	0.39	7
		Medium	0.33	23
		Rich	0	0
		Total	0.36	30
	Wargba	Poor	0.5	7
		Medium	0.86	20
		Rich	1	3
		Total	0.79	30
Area under rain fed	Kara	Poor	0.18	7
		Medium	0.29	23
		Rich	0	0
		Total	0.16	30
	Wargba	Poor	0.36	7
		Medium	0.61	20
		Rich	0.83	3
		Total	**0.60**	**30**

Source: Survey result

5.2.1.2 Land tenure Arrangements in the Irrigation Systems

Irrigators in Wargba and Kara access irrigation land mainly through two major land right institutions, namely ownership right and use right. Government distribution (70%), inheritance (26.7%) and gift (3.3%) were the major tenure systems through which the sample plot holders in Wargba obtained the land they own (Table 5.10). As regards Kara, government redistribution (80%) and inheritance (20%) are the most important, in that order, land right institutions through which the sample irrigators obtained their irrigable land (Table 5.10). In addition to inheritance, plot holders in both irrigation systems share their land and transfer ownership rights to their young sons (who are going to establish themselves as new households) and landless relatives in the form of gift (see table 5.10) particularly this has been the case in Wargba irrigation scheme.

Table 5.10: Possession of irrigable land ownership right

Name of Irrigation Scheme	**How do you get your irrigable land?**		
	Inherited from family	**Gift from relative**	**Distribution by government**
Kara	20%	0%	80%
Wargba	27%	3%	70%
Total	**23.3%**	**1.7%**	**75.0%**

Source: survey result

5.2.1.3 Assessment of factors for Lease out/in arrangement

Among the survey household who have irrigable land but preferred to lease-out their land on rental arrangement for dismal return, they accord high importance for shortage of money to buy input (100%), shortage of oxen and money to hire labor (90%), shortage of money to cover water fee (70%), shortage of improved seed (50%) and lack of know-how on irrigation practices (10%) respectively in their order of importance for Kara SSIS irrigators. Similarly, Wargba non-irrigators accorded high importance to shortage of money to buy input (100%), shortage of money to cover water fee (90%), shortage of oxen and shortage of money to hire labor (80%), shortage of improved seed (70%) and lack of know-how on irrigation practices (30%) respectively in their order of importance respectively. In summary, all the sampled non-irrigators have attribute high importance for the first three reasons as depicted in table 5.11 below. This implies that there are vivid factors that forced households to lease-out their irrigable land for dismal rental arrangement. All these reasons mentioned by households who lease-out are both indigenous and exogenous factors that can be addressed with appropriate institutional and organizational support.

On the other hand, among the sampled irrigator households in both irrigation scheme 25% and 15% for Kara and Wargba, respectively lease-in additional irrigation land on rental arrangement and attach high importance to the fact that there is good market opportunity for their produce and high return of irrigation practice. This clearly indicates that there is good reward to engage in irrigation if farmers had the minimum pre-requisite input such as shortage of money to cover operational expenses including hiring of labor, oxen to plough their land and access for supply of improved seed varieties at fair price.

Table 5.11: Farmers' ranking of the reasons for leasing-out/in irrigable land

Reason for lease out	% of respondents and rank Kara SSIS N=10			% of respondents and rank Wargba SSIS N=10		
	N	%	Rank	N	%	Rank
Shortage of money to buy input	10	100%	1	10	100%	1
Shortage of oxen	9	90%	2	8	80%	3
Shortage of money to hire labor	9	90%	2	8	80%	3
Shortage of money to cover water fee	7	70%	3	9	90%	2
Shortage of improved seed	5	50%	4	7	70%	4
Lack of know-how on irrigation practices	1	10%	5	4	40%	5
I have plenty of land	1	10%	5	3	30%	6
Reason for lease-in	**% of respondents and rank Kara SSIS N=20**			**% of respondents and rank Wargba SSIS N=20**		
Good market opportunity	5	25%	1	3	15%	1
Irrigation is more profitable	5	25%	1	3	15%	1
No other occupation during dry season	3	15%	2	3	15%	1
No adequate own land	2	10%	3	1	5%	2
I have adequate labor	2	10%	3	1	5%	2

Source: Survey result

5.3 Irrigation Management Practices within the Irrigation Systems

5.3.1The structure and Function of WUA

Ethiopia's policy framework for development of small scale irrigation (SSIS) clearly outlines that management and operation of SSIS is the joint responsibility of the regional state irrigation agency, cooperative promotion and input supply desks, district water supply and irrigation agency, and village level administrative and legal entities and farmers and their organizations (Shimelis Dejene, 2006). In line with this, management of the deep well modern pump irrigation structure in Kara and Wargba irrigation scheme was delegated to water user association. The water user associations have nominated water management committees (WMC) in a democratic election. Water user management committees (in each irrigation system) have been vested with the following general responsibilities: water allocation, distribution, conflict management and maintenance.

Specifically, the Water User Committees have been tasked to:

- Allocate water and controls proper distribution of water
- Observe the water rights of members
- Ensure the safety of the schemes through organizing operational and management works and mobilizing resources for these works
- Ensure proper use of the drip irrigation accessories by irrigators
- Resolve disputes related to land, water and maintenance based on their bylaws.

One of the social requirements for successful irrigation is organization and management structure that suit the irrigation infrastructure (Mollinga, 2003;

Woldeab, 2003). The water users in both irrigation systems have also created management structures that suit layout of the irrigation schemes. Executive committees, sub-committees and water user teams were formed in the hope of better coordination of O and M activities.

An Executive Committee consisting of five members in each irrigation system is responsible for operation and maintenance (O and M) of the irrigation systems. The general assembly is the highest body, which make the final decisions based on the bylaws (***sirit***) and recruitment of water technician who is responsible for developing water distribution schedule and minor maintenance. The composition of the WUA committee members has chairman and vice chairman, a secretary, treasurer, control and monitoring committee.

Organizational set up and management functions of the committees are further decentralized depending on layout of the schemes. All water users in the irrigation systems constitute the water users team (WUT/'Cluster') grouped to cover four hectares. Sub- committees comprising three members are in charge of control of water distribution and coordination of maintenance activities in the respective territory units (TUs). As a rule, they are accountable to the executive committee and expected to report to the board when regulations in the water distribution by-laws are violated. However, they did not effectively discharge this responsibility as stipulated in the O and M manual because of organizational and institutional weaknesses and socioeconomic constraints discussed in the different sections of chapter five.

5.3.2 Water pricing, allocation and distribution

From the focus group discussion with users in both irrigation systems, it has been learnt that the water pricing mechanism is based on charges set at same rate per one plot (0.25 hectares) but the charge doesn't vary on volume of water. The monthly water fee is 500 birr per month per one plot (i.e 0.25 hectares).

The WUA bylaw (sirit) in both schemes clearly outlined that the water allocation and distribution task is vested to the Water Use Management committees established in each scheme. However, the WUA have further delegated the task to an external body called water technician employed by the WUA in each irrigation scheme while the WUA play supervisory role to ensure that water allocation and distribution have been made as per the details of the arrangement agreed and put forward in the respective WUA by-laws. Moreover, the irrigation agronomists and DAs are also supposed to provide technical assistance to water committees in water allocation, in preparing the annual schedule for water distribution and in defining the water rights of members based on study on water requirements of different crops and irrigable plot area and measurement of the yearly water supply. However, both the multipurpose DAs and the Irrigation Desk did not maintain strong link with the water committees and did not provide them with the required technical assistance in undertaking these water management tasks.

The designed irrigation season for the projects is throughout the year. The Water Use Management Committee calls a meeting and coordinates maintenance and drip irrigation accessories checkup and replacement activities. They allocate water and prepare rotational schedules for each of the clusters every year in September. However, water users do not; in spite of the law (bylaws), register types of crops they grow (vegetables or perennials) for clear definition of water rights of individual farmers and clusters and to adjust the rotational schedule with the yearly water supply. This have had also a deterrent effect on the possibility for proper allocation and scheduling of water distribution by the WUAs-committee.

Water allocation and rotational schedule, which was prepared and being implemented by the water committees has got limitations in terms of both design and implementation. In terms of design, water allocation is made uniform across all clusters despite variation in water requirement by planted crop type in each cluster. Equal water supply period per turn are allocated for all clusters and individual water users. Amount and time of water supply are not defined in accordance with the water requirements of the different crops grown and area of irrigable plots managed by individual irrigators and clusters. This arrangement does have some effect on the overall productivity of planted crops. However, participants of group discussion held in *Wargba* explained the arrangement as most fair despite the following limitations they pointed in the following manner.

"*The committee allocates water uniformly turn by turn for households in a given cluster or territorial units. The distribution schedule has many limitations. Equal water delivery period per turn is allocated for all TUs in spite of the variation in water demands indifferent TUs. In addition equal number of irrigation hours is assigned for all irrigators within a TU with different land holding size and different crops grown. Amount and timing of water supply are not specified based on water requirements of the different crops and plot area. This has often led, within a TU and among TUs, to ineffective use (misuse) of water due to oversupply or under* *supply, and in justice in water allocation, scarcity, and conflict and crop failure due to unreliability of water*".

Another informant in Kara expressed the negative effects of the ill- designed rotational schedule and lack of clearly defined of water rights (within the irrigation systems) on management of water distribution within clusters and among clusters as follows:

"*Water is supplied simply for about 24 hours for each cluster per turn. The number of irrigators in one cluster ranges from 2 to 8 households. Within this timeframe water does not reach to all members of the team. It is diverted to other groups soon after the supply period per turn is over but before all farmers (claimants) in a cluster get irrigation water. Even during the second turn, those farmers who did not obtain water during the previous turn may not get priority once their turn is over.* "

5.3.2.1. Performance of WUA in Water Distribution

WUAs-committees consisting of five members coordinate and controls water distribution in each irrigation system. The most important performance indicators in the distribution of irrigation water include adequacy, timeliness and equity in the supply of water (World Bank, 2000).

Table 5.12 shows users' evaluation of performance of WUAs-committee in water distribution. The WUAs in both irrigation systems were found to be efficient in managing water distribution in terms of the three indicators with only less than a third of the surveyed households responded problems in water distribution while over 70% of the respondents in both irrigation scheme labeled the performance of the WUAs committee as being satisfactory in terms of the three performance indicators.

Despite this fact, 27% of respondents in Wargba questioned the timeliness of the water distribution and additional 23% of the respondents raise concern on the adequacy of the water distribution while the concern on water distribution is not as such daunting in case of Kara irrigation system with only 13% of the respondents reflect having concern on the timeliness of the water distribution implying that WUAs are performing relatively better in Kara as compared with Wargba WUAs-committee.

Table 5.12: Water user opinion about water distribution in Kara and Wargba irrigation schemes

Description	Opinion by irrigation system and location			
	Kara N=30		Wargba N=30	
	Count	%	Count	%
Enough water is not received (Adequacy)	2	6.7	7	23.3
Water is not received when needed (Timeliness)	4	13.3	8	26.7
Water distribution is unfair (Equity)	0	0	1	3.3

Source: survey result

5.3.3 Enforcement of Water Right and Rules and conflict management

The enforcement of water rights and rules in Kara and Wargba SSIS has been the responsibility of selected WUA (*Abo-Mais)* in each scheme. These *Abo-Mais* have rules and regulations locally known as the *Sirit* by which they enforce the fair distribution of water and regulate any offence against the smooth running of the system. According to the contacted Water committee members, the *Sirit* is said to comprise a comprehensive set of rules covering all aspects of interest. As a result though there is serious water scarcity one of the explanations given on the successful and healthy running of the SSIS is that the majority of the farmers act according to the *Sirit* and offenders are penalized.

Table 5.13: Assessment of farmer's view on enforcement of the by-law

Description	***Opinion of farmers on enforcement of internal bylaws and performance of WUA by irrigation system***					
	Kara		***Wargba***		**All HH**	
	Count	***%***	***Count***	***%***	***Count***	***%***
Have your internal bylaw been enforced?						
Yes	23	76.7	21	70	44	73.3
No	7	23.3	9	30	16	26.7
Is there conflict over irrigation water						
Yes	5	16.7	8	26.7	13	21.7
No	25	83.3	22	73.3	47	78.3
Cause of conflict						
shorter time allowed for irrigation water flow	4	13.3	7	23.3	11	18.3
competition due to increased number of water users	4	13.3	7	23.3	11	18.3
water theft or downstream conflict	2	6.7	3	10	5	8.3
water use administration problem	0	0	3	10	3	5
Performance of WUA in resolving conflict						
They take immediate action	15	50	19	63.3	34	56.7
They suspend case	0	0	2	6.7	2	3.3
They don't enforce internal bylaw	7	23.3	9	30	16	26.7
Conflict management has been improved	7	23.3	11	36.7	18	30

Source: Survey Result

From the sampled farmers in both irrigation schemes, 73% believe that the by-law (*Sirit)* has been implemented by the WUAs in a way it is formulated in their respective schemes. This shows that the farmers have considerable trust over the WUAs. In essence, a strong adhesion to the rules and regulations by the WUAs is observed. Farmers in the study sites express their solidarity to the *Sirit* for the fact that they need to stay with social norm. The fact that only negligible individuals derogate temporarily from the norms, which consequently receive pertinent penalty, contributes to the effectiveness and sustainability of the institution itself. If the rules and regulations are violated and the violators are not negatively rewarded (penalised), it can result in local conditions of a free access to the resources.

With regard to incidence of conflict, only 21% of the surveyed households in both irrigation scheme reported incidence of conflict with higher percentage of conflict incident being reported from Wargba irrigation scheme. The farmers who responded incidence of conflict mentioned two major causes of conflict. First, the fact that shorter time allowed for water flow cause conflict among farmers in neighboring clusters. Second, conflict arising due to increased number of users.

Despite the existence of certain level offences the survey result depicted in Table 5.13 indicates that 50 and 60 percent of the surveyed households in Kara and Wargba irrigation scheme respectively praised the performance of the WUAs in terms of taking immediate action for conflicts arising in use of irrigation water while only 3% of the surveyed households in both irrigation schemes reported that WUAs suspend cases. This clearly indicates that there is a significant level of discipline reigning in individual farmers in respecting the communal interest in managing the irrigation system. The survey outcome also confirms this with 50% of the surveyed household in both irrigation scheme reported to have the opinion that conflict management has improved overtime.

5.3.4 System maintenance

It is a well shared fact that system maintenance is a critical element in the operation of small scale irrigation scheme. The key informant interview and focus group discussion with WUAs attested that there is good organizational set up in terms of providing timely maintenance as most of the WUAs have been trained on minor maintenance activities and most WUAs in the survey scheme have also hired water technician who is responsible for overall management of the irrigation schemes' operation including system maintenance and design proper water distribution schedule in line with the details of the respective scheme by-laws or *sirit.*

Besides, nearly 75% of surveyed household in both Kara and Wargba reported the maintenance of the scheme either good or acceptable (Table 5.14) with frequency of maintenance being twice a year as reported by nearly 50% of the surveyed household in both irrigation schemes and a quarter of the surveyed households in both irrigation scheme reported the frequency of maintenance as once and trice in a year.

Table 5.14: Farmers' opinion on maintenance of the schemes

ITEM	*Kara (N=30)*		*Wargba (N=30)*		All HH	
	Count	*%*	*Count*	*%*	*Count*	*%*
What does maintenance of the scheme look like?						
Good	20	66.7	25	83.3	45	75.0
Acceptable	3	10.0	2	6.7	5	8.3
Poor	7	23.3	3	10.0	10	16.7
Frequency of maintenance						
Once in a year	9	30.0	8	26.7	17	28.3
Twice in a year	17	56.7	11	36.7	28	46.7
Trice in a year	4	13.3	11	36.7	15	25.0

Source: Survey result

5.4 Irrigation Practice and support services

5.4.1 Assessment of overall irrigation practice

While reviewing the overall irrigation practices, it has been noted that 80% of the survey household irrigate all of their irrigable land as of the survey period in both irrigation schemes and the average land accessible for irrigation is higher in case of Wargba with nearly 60% of the surveyed households responded that they access over 0.5 hectares of their land to irrigation while only 40% of households in Kara responded that they access the same amount of their land to the irrigation scheme (Table 5.15). On the other hand, 80% of survey household in Wargba responded that they have between 1-3 year irrigation practices while nearly 57% of the survey household in Kara reported having over 4 years irrigation practices. Reportedly, respondents in all the schemes unanimously responded that their water delivery system is modern which is water pump using electric water pump and only less than quarter of the respondents got access for specialized training on irrigation with slight higher percentage of sampled households (37%) reported to received specialized training in case of Kara irrigation scheme compared to Wargba, which is only 30%.

From the key informant discussion it has been learnt that on average 42-94 households use one irrigation scheme in Kara and 54-96 households in Wargba. In line with this, there are a total of five and four modern irrigation schemes in Kara and Wargba locality benefiting 314 and 319 households reaching a command area of 142 and 143 hectare respectively (RoWRD, 2012).

Table 5.15: Irrigation practice of the study area

Irrigation practice	*Responses*	*Kara (N=30)*		*Wargba (N=30)*	
		No. of HH	*%*	*No. of HH*	*%*
Do you irrigate all of your irrigable land	Yes	20	80.0	20	80.0
	No	10	20.0	10	10.0
Amount of land accessible for irrigation	less than 0.5 ha	11	36.7	12	40.0
	0.5-1 ha	10	33.3	14	46.7
	>1.25 ha	2	6.7	4	13.3
No. of years practicing irrigation on the scheme	<1 Year	4	13.3	4	13.3
	1-3 Years	9	30.0	23	76.7
	4 years and above	17	56.7	3	10.0
Water delivery system	Water pump using electric water pump	30	100.0	30	100.0
Do you receive specialized training on irrigation	Yes	11	36.7	9	30.0
	No	19	63.3	21	70.0

Source: Survey result

5.4.2 Support services

5.4.2.1 Agricultural extension support

According to Van Den Ban and Hawkins (1988) as cited in Lemma (2004), the main aim of extension program is to initiate change to bring about sound agricultural development especially on the part of smallholder farmers. It offers them technical advice and also supplies with the necessary inputs and services. Agricultural extension is therefore used as a tool for rural development. On the other hand, extension work is not an arbitrary activity. It requires systematic planning in order to bring about the desired change.

In view of the above fact, the survey result indicated that nearly 70% of surveyed household's in each irrigation system have received training on irrigation management. However, the focus group discussion with the sampled households revealed that the training was given at the start of the irrigation system in 2007/8 and no other similar trainings were received thereafter leaving the farmers vigilant to farm level complication. In essence, the Farmers practice irrigation without essential technical know-how on crop water management, water application methods and irrigation intervals. For instance, according to the estimates of farmers producing tomato, the production lose is about one third because of farm level mismanagement and post-harvest mishandling. That means, on farm level, farmers do not apply the technique of keeping the tomato plant on the raised bed to prevent its fruits from attaching to the ground, which causes decrease in its quality. In line with this, the Irrigation Development Agent (DAs) assigned in each tabia or irrigation system although supposed to provide at spot level technical assistance to irrigating farmers but failed to do their task for they have been busy with administrative task and also lack the required technical capacities as they also don't receive regular training except the basic training they received from college.

The development agents also complain that they have no clear job description. In addition to their conventional agricultural extension activities they engage in different tasks such as farm inputs distribution, collection of loans including land use taxes, participation in various administrative and political committees. They believe that this creates suspicion on the part of farmers in relation to DAs role. This would erode DAs confidence of becoming the trusted advisors.

In a nutshell, it can be summarized that irrigation extension service mainly provision of regular technical assistance and information on cash crop production and marketing is very low (non-existent).

The existing cropping pattern has been found to be ineffective and the cropping intensity is also below the expectation. In most cases, majority of farmers produce twice in a year by using irrigation water. From the study, it was understood that farmers tend to concentrate on few cash crops mainly of tomato, onion and pepper making the irrigating farmers vigilant to middle traders who under-estimate the farm level price of these cash crops (Table 5.20).

5.4.2.2 Input and output marketing

In the production of high value horticultural crops, both input and output side of marketing is considerably important (Lemma, 2004 PP: 64). The survey outcome in this regard indicated that low and fluctuating price, and small size of market (low demand) is the very important limiting factor for both irrigation systems.

From the study it was discovered that acquisition of inputs from local market (cooperative and extension agency) could not meet the demand of farmers. Therefore, farmers relay on outside dealers. For instance, surveyed households' in both irrigation scheme often times procure the improved seed variety and other farm inputs from outside dealers with only 37 and 53 percent of the respondents in in Kara and Wargba respectively reported that they got improved seed from the Agricultural Office within the district.

In relation to output marketing, even though both schemes are not far from the main road that access to major towns like Alamata, Mokeni, Mekele and Maichew, the marketing system is not well organized. The surveyed households in both irrigation schemes mentioned quite abruptly that they face problem in marketing their produce which is mainly low price as reported by 77 and 90 percent of respondents in Kara and Wargba irrigation system respectively.

The survey has also revealed that market price for their price was very cheap during harvest and expensive during non-harvesting season leaving the farmers victim of the prevailing poor institutional support on marketing of their produce. This is the case as the nearby local markets do not have the capacity to absorb the perishable produce of farmers. At the same time, the price received by farmers in the primary markets is relatively lower than what they could have received in other big markets. Market information on the part of farmers is non-existent. As a result, farmers do not have the bargaining power to determine the price of farm produce; instead they accept the price given by the traders. In line with this, most farmers sell their produce at field level to traders (see table 5.16 below) and often times the farmers sell their produce as individual implying no institutional support in organizing the farmers in to cooperatives.

Table 5.16: Farmers' opinion on marketing of their produce

Issues on marketing	*Opinion of farmers' on marketing of their produce by irrigation system*			
	Kara (N=30)		*Wargba (N=30)*	
	Count	*%*	*Count*	*%*
How do you sell your produce?				
Take the produce to the market	14	46.7	23	76.7
Traders buy from the field	23	76.7		0.0
How do you sell your produce?				
As individual	23	76.7	27	90.0
Group	0	0.0	0	0.0
Do you face problem in selling your produce				
yes	23	76.7	27	90.0
No	0	0.0	0	0.0
Type of problems faced in selling your produce				
low price	23	76.7	27	90.0
Low demand for the produce	10	33.3	12	40.0
Price of the HH produce on the local market during harvest season				
Very cheap	21	70.0	26	86.7
Competitive	2	6.7	1	3.3
Price of the HH produce on the local market during non-harvest season				
Competitive	7	23.3	6	20.0
Expensive	15	50.0	20	66.7
Is there Government effort to create market access for your produce				
Yes	0	0.0	0	0.0
No	23	76.7	27	90.0

Source: Survey data

5.4.2.3 Credit Facility

Irrigation farm management requires more financial input than rain fed agriculture do. To this end, access to credit facility is very crucial element. From the key informant interview, it has been noted that credit facility is available in the study area mainly through Dedebit Saving and Loan Institution (DESCI), however, only 23 percent of the surveyed household in Wargba reported that they use credit for their irrigation activity while none of the surveyed households' in Kara (where Muslim followers dominate) use credit for their irrigation activities. The factors that explain this tragedy are: lack of credit facility in nearby location, fear of the high interest rate, lack of credit supply on demand and religious factors mainly for Muslim communities.

In line with this, 33 percent of respondents from Kara replied that they don't need credit for their irrigation activity while considerable number of the respondents in both irrigation schemes attributes this to lack of credit facility on time of demand and religious reasons (particularly this is true in Kara where there are many Muslims in which loan is considered as *haram*).

There are of course very few farmers who become self-sustained in fulfilling productive capital requirement provided that production and market conditions are conducive for them.

The Irrigation Water Users' Associations (WUAs) of the two irrigation systems are also not in a position to provide credit to members. For instance, as it is indicated in Table 5.17, of the major constraints, lack of credit facility was rated as the first crucial constraint by both irrigation systems. Therefore, it can be safely argued that the financial constraint would considerably weakened irrigation efficiency as a whole.

Table 5.17: Opinion of farmers on availability of extension support

Type of extension support	Opinion of farmers on extension support by irrigation system			
	Kara (N=30)		Wargba (N=30)	
	Count	%	Count	%
HH who receive training on Irrigation Management	21	70.0	22	73.3
HH who use of credit for irrigation	0	0.0	7	23.3
Reasons for not taking credit				
No need	10	33.3	4	13.3
No credit facility	3	10.0	10	33.3
High cost of credit	0	0.0	5	16.7
Religious reasons	10	33.3	5	16.7
HH who use improved seeds				
Onion	22	73.3	26	86.7
Tomato	21	70.0	25	83.3
Pepper	12	40.0	5	16.7
potato	3	10.0	2	6.7
Source of improved seed				
Market	22	73.3	20	66.7
Office of agricultur4e	11	36.7	16	53.3
Cooperative	1	3.3	0	0.0
Research centers	1	3.3	0	0.0

Source: Survey result

5.4.2.4 Constraints on Irrigation Management

As briefly discussed earlier, Kara and Wargba irrigation system is dominated by small holder farmers, which have at least some element of commercialization. However, there are a number of constraints that challenges farmers' better performance in use of the irrigation schemes. In light of the various constraints facing irrigating households, lack of government support, shortage of farm implements, market problem, lack of skill training on irrigation management and inadequate credit facilities have been mentioned as major constraints in their order of importance which affect the effective and efficient implementation of the irrigation schemes as depicted in table 5.18 below.

Table 5.18: Critical Problems affecting irrigation performance as rated by the respondents

S/N	Factors	*Opinion of farmers on critical factors affecting irrigation performance by irrigation system*				Ranking
		Kara (N=30)		*Wargba (N=30)*		
		Count	*%*	*Count*	*%*	
1	Shortage of farm implement	23	76.7	26	86.7	2
2	Lack of government support	25	83.3	25	83.3	1
3	Lack of skill training on irrigation management	20	66.7	24	80.0	4
4	Market Problem	23	76.7	24	80.0	3
5	Lack of credit facility	12	40.0	22	73.3	5
6	High competition	10	33.3	17	56.7	6
7	Crop damage	9	30.0	17	56.7	7
8	Irrigation water shortage	3	10.0	1	3.3	8

Source: Survey result

5.5 Impact of Irrigation

5.5.1 Positive impact of irrigation on household food security

Many scholars in the subject have attested that irrigation had contributed towards improvement of irrigators' livelihoods through its effect on qualitative factors such as improvement in food intake (both frequency and type of food varieties), increase in money spent on education and health; changes in ability to cope with draught, reduce in crop failure and increased production, change in number of crops sold in income generating, increase in terms of employment opportunities, etc. In light of the above established premises, surveyed households have been asked to qualitatively evaluate the positive impact of irrigation. Accordingly, the survey outcome in table 5.19 below depicts that over 90% of the surveyed irrigation users in both irrigation schemes have reported positive impact in terms of key qualitative indicators while only less than 35% of the non-irrigating households in both schemes claim to have seen positive impact of the irrigation on their lives as depicted in Table 5.19 below.

On the other hand, quantitative indicators were also considered to assess the impact of the irrigation schemes on households' income in which the survey outcome as indicated in Table 5.20 below showed that irrigators in both irrigation schemes have claimed to increase their income from sales of their produce as compared to income generated by non-irrigators who preferred to lease out their land for meager rent.

The survey result in this regard revealed that irrigators in both schemes reported higher average household net income from all irrigation income sources in 2012 is 11,422 and 13,588 birr in Kara and Wargba irrigation system respectively as compared to non-irrigators whose average household net income is 4,280 and 2,872 birr in Kara and Wargba irrigation system respectively. Irrigation users' average net income was nearly three times and five times that of non-irrigators' average net income in Kara and Wargba irrigation schemes respectively.

Moreover, the average household net income from all sources in 2012 was relatively higher in Wargba (see Table 5.19.). This is mainly attributed to their relative small distance to market outlet and more importantly higher crop diversification in *wargba* irrigation system. On the other hand, non-irrigators who reported meager net income have attributed this to failure to develop the irrigated area by them-selves for varied reasons mentioned in section 5.4.1.4 above.

Table 5.19: Surveyed HHs opinion on positive impact of irrigation

Irrigation positive impact indicators	Irrigating HHs (N=40)		Non-Irrigating HHs (N=20)	
	Count	**%**	**Count**	**%**
change in number of meals eaten per day	38	95.0	7	35
Change in type and variety of meals eaten per day	38	95.0	7	35
change in amount of money spent on education, health, etc.	37	92.5	6	30
Change in ability to cope with draught	37	92.5	4	20
Reduce in crop failure and increased production	37	92.5	0	0
Change in number of products sold for income generating	37	92.5	0	0
increased employment opportunities	33	82.5	0	0

Source: Survey result

Table 5.20: Household net income from irrigation in FY 2012

Location of irrigation system	***Statistics***	***Net household income by irrigation system (Eth Birr)***	
		Irrigators	***Non-Irrigators***
Kara	Mean	11,422.4	4,280
	N	20	10
	St. Dev	9,746.1	2,989.9
Wargba	Mean	13,588.15	2,872.5
	N	20	10
	St. Dev	23,085.4	1,863.8

Source: Survey result

5.5.2 Impact of irrigation on crop diversification

Most scholars on the subject argued that one of the most important social effects of irrigation projects was increased diversification of production. One method to show the impact of the intervention on diversification is through comparison of types of crops cultivated by farmers before and after irrigation. Survey findings in this regard (table 5.21) indicated that the types of crops and the number of farmers who grew a wide range of horticultural crops, including onion, tomato, pepper, potato, cabbage, chat, avocado, and mango has substantially increased after irrigation in both irrigation system (Table 5.21). In this connection, the surveyed household in both irrigation schemes have attributed such shift from traditional cereal crops to cash crops for the following compelling reasons: better price, high production and easy to operate in their order of importance (Table 5.22).

However, the survey revealed that apart from the horticultural crops, production of *teff* has been reported by over 70% of surveyed household in both irrigation schemes even after the construction of irrigation schemes which is partly due to high return from sales of *teff* and the relatively less time required for agricultural practice of *teff*. Besides, the fact that *teff* is the dominant staple food for urban dwellers in Ethiopia have high trade-off to produce the crop using irrigation.

Table 5.21: Comparison of agricultural diversification before and after irrigation

Type of products	***Wargba (N=20)***				***Kara (N=20)***				***All Irrigating HH (40)***			
	HH growing the crops				***HH growing the crops***				***HH growing the crops***			
	Before		***After***		***Before***		***After***		***Before***		***After***	
	N	***%***	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***
Sorghum	19	95	5	25	15	75	1	5	34	85	6	15
Maize	17	85	9	45	13	65	2	10	30	75	11	27.5
Teff	19	95	12	60	18	90	17	85	37	92.5	29	72.5
Tomato			18	90		0	18	90	0	0	36	90
Onion			18	90		0	18	90	0	0	36	90
Pepper			7	35		0	8	40	0	0	15	37.5
Cabbage			1	5	1	5	6	30	1	2.5	7	17.5
Potato			4	20		0	2	10	0	0	6	15
Avocado			0	0		0	1	5	0	0	1	2.5
Mango			0	0		0	1	5	0	0	1	2.5
Chat			2	10		0	1	5	0	0	3	7.5

Source: Survey result

The second most visible impact (social effect) of the implemented irrigation projects was increased intensification of land use practices (temporal diversification of production) in both irrigation systems. The proportion of surveyed households who grew twice or thrice a year was over 70 percent of the sampled households' in both irrigation schemes as depicted in Table 5.22 below.

Table 5.22: Household's opinion on intensification of land use practices after irrigation

How many times the households produce annually using irrigation?	Level of intensification by irrigation system			
	Kara (N=30)		Wargba (N=30)	
	Count	%	Count	%
Once	10	33.3	8	26.7
Twice	15	50.0	17	56.7
Thrice	5	16.7	5	16.7

Source: survey result

5.5.3 Impact of irrigation on possession of productive asset

There are different views regarding the effect of irrigation development on possession of productive asset mainly of livestock ownership. For instance (Fuad.A, 2001:34) indicated that irrigation of any scale has a drastic effect on livestock production because of the competition for land. On the other hand, there is a view that cash income generated from irrigation farming will be an important source of investment on livestock and crop residues from irrigation production is a supplementary source of animals feed during the time of feed shortage.

The intention of the analysis in this regard was to examine the wealth status of households in relation to having access and no access to irrigation in the study area. Accordingly, the survey result depicted in Table 5.23 below revealed that irrigating households in both Kara and Wargba irrigation scheme own more productive assets after engaging in irrigation than the non-irrigators. Nearly, 85 and 50 percent of irrigating household in Wargba and Kara irrigation schemes respectively own at least one ox as compared to 10 and 30 percent non-irrigating households' who reported to own at least one ox.

Moreover, type of productive assets owned by irrigating household in both irrigation schemes is considerable as compared to limited asset ownership reported from Non-irrigating households'. This clearly indicates that irrigation attribute a lot to increased asset ownership for those who irrigate the land accessible to irrigation scheme than those households who obliged for different reasons to lease out their irrigable land for meager rent leaving the latter at a disadvantage. This argument has been supported by Shimelis Degene (2006) who revealed the positive nexus between irrigation practices and increased investment in productive asset.

Table 5.23: Asset ownership of irrigating and non-irrigating households in both schemes

Type of Productive Asset	*Number of irrigators and Non-Irrigators who own at least one productive asset by irrigation system*							
	Irrigating HH				*Non-Irrigating HH*			
	Kara (N=20)		*Wargba (N=20*		*Kara*		*Wargba*	
	Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
Oxen	10	50.0	17	85.0	1	10.0	3	30.0
Sheep	3	15.0	3	15.0	1	10.0	1	10.0
Goat	1	5.0	0	0.0	0	0.0	0	0.0
Cow	4	20.0	11	55.0	0	0.0	2	20.0
Agricultural equipment	5	25.0	8	40.0	1	10.0	1	10.0
Camel	3	15.0	0	0.0				
House	4	20.0	2	10.0				
Cart	0	0.0	3	15.0				
Bed room	0	0.0	1	5.0				
Money saved in bank	1	5.0	2	10.0				

Source: survey result

5.6 Constraints and challenges in the implementation of the irrigation schemes

Despite the dire positive impact noted in the above sections, surveyed irrigating households have noted key constraints and challenges that deter the efficiency of the constructed irrigation schemes. Participants of the focus group discussion in both schemes have noted that investment in the water intensive horticultural crops has become a risky business in both schemes because of frequent crop failure arising from crop disease, shortage of water and lack of technical know-how on proper use of insecticides and fertilizers. In line with this premises, 95% and 93% of the sample households in Kara and Wargba irrigation schemes, respectively have faced crop failure at least once in one production year (Table 5.24).

Apart from crop failure, surveyed households in Kara and Wargba irrigation schemes have noted the following constraints in their order of importance: lack of market for their produce, shortage of farm inputs particularly improved seed and insecticides, shortage of labor, lack of input financing, water shortage and lack of technical skill (Table 5.25).

Table 5.24: irrigating households who faced crop failure by irrigation system

Items	Kara		Wargba		All HH (N=40)	
	Count	%	Count	%	Count	%
Do you face crop failure?						
Yes	19	95	17	85	36	90
No	1	5	3	5	4	10
Reasons for crop failure						
water shortage	2	10	3	15	5	12.5
Crop disease	16	80	18	90	34	85
Lack of technical know-how on use of insecticides	11	55	13	65	24	60

Source: Survey result

5.25: Opinion of irrigating households on constraints facing in using the scheme more efficiently

Constraints in using the irrigation schemes	Kara (N=20)		Wargba (N=20)		All HH (40)	
	Count	%	Count	%	Count	%
Lack of market for produce	19	95	16	80	35	87.5
Unavailability of input	12	60	16	80	28	70
Lack of input financing	5	25	3	15	8	20
Shortage of labor	1	5	8	40	9	22.5
Water shortage	5	25	3	15	8	20
Lack of technical skill on irrigation agronomy practices	8	40	6	30	14	35

Source: Survey result

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

At the outset the research study had paid significant emphasis on analysis of the impact of household's access to irrigation facilities on improving household's food security in Raya-Azebo Woreda, Tigray region.

In this study attention was given to assess the role of creating access to irrigation facilities on improving households' food security in terms of increase in income, crop diversification and asset possession of households in the study area along with exploring existing organizational/institutional set up and factors inhibiting households not to fully engage in irrigation activities.

The study Woreda is one of the most drought prone and food insecure areas of Tigray region. During the past few decades, the area has been stricken by drought and unreliable rainfall, which resulted in acute food shortage and abject poverty of the community. Consequently, food aid has become an institutional feature of the study area.

Despite the recurrent drought that give rise for low productivity in the study area, it is believed that crop production can be sustainable through development of small-scale irrigation schemes in areas endowed with underground water potential. The result of this study also reveals that in the history of drought in the area, those households who have access to irrigation have survived better than their non-irrigation counterparts.

Since the 1980's the Ethiopian government has given attention to small-scale irrigation development as a means of combating drought situation and improving household food security. Accordingly, the Federal government have embarked in developing areas with underground potential among which the Raya Valley deep well development project for small scale irrigation project commenced on 2007/08 with planned command area of 267 hectare in the first phase (2007/08 to 2008/09) to benefit 72,000 households in Raya Valley which encompasses Raya-Azebo and Alamata district. In 2009/10 it constructed additional deep wells that have irrigation potential of additional 300 hectares of land.

The finding of this study shows that the modern deep wells small scale irrigation schemes in Kara and Wargba of Raya-Azebo district have created new potential for the small-holder farmers to improve their livelihood by switching from traditional food staples such as maize, teff and sorghum to cash crops mainly of vegetables (onion, tomato, pepper, cabbage, and chat) and in few cases fruits (mango and Avocado). Among the surveyed households in both irrigation schemes, over 90% of the irrigating households have accorded positive impact in terms of both qualitative and quantitative measures which includes:

- increased food intake both in term of varieties of food consumed and frequency of consumption, increase in money spent on education and health; changes in ability to cope with draught, reduce in crop failure and increased production, change in number of crops sold in income generating, increase in terms of employment opportunities, etc.

- Average net income from irrigation for irrigating households is three times and five times higher than average net income generated by non-irrigating households in Kara and Wargba irrigation schemes, respectively;
- Irrigating households' have witnessed increased crop diversification after using irrigation. The survey result indicated that the types of crops and the number of farmers who grew a wide range of horticultural crops, including onion, tomato, pepper, potato, cabbage, chat, avocado, and mango has substantially increased after irrigation in both irrigation system and such shift have been attributed for the following compelling reasons: better price, high production and easy to operate in their order of importance.
- Increased intensification of land use practices (temporal diversification of production) in both irrigation systems. The proportion of surveyed households who grew twice or thrice a year was over 70 percent of the sampled households' in both irrigation schemes.
- Increase in possession of productive asset by irrigating households. The survey result shows nearly 85 and 50 percent of irrigating households in Wargba and Kara irrigation schemes respectively own at least one ox as compared to 10 and 30 percent non-irrigating households' who reported to own at least one ox. Moreover, number and type of productive assets owned by irrigating household in both irrigation schemes is considerably high as compared to limited asset ownership reported from Non-irrigating households'.

With regard to institutional/organization set up, it has been found that WUAs have been formed in all irrigation schemes and developed group by-laws, locally known as *sirit. Besides,* the irrigation schemes have been classified by clusters to effectively manage the water allocation and distribution. Performance of the WUAs in terms of water adequacy, timeliness and equity have been reported as satisfactory with over 70% of the surveyed households express their satisfaction with the performance of the WUAs in both irrigation schemes in term of the three performance indicators. Similarly, incidence of conflict have been reported minimal with only 21% of surveyed households in both irrigation scheme reported incidence of conflict However, institutional support in terms of provision of extension support in irrigation agronomy, credit supply, market linkages and agricultural input supply (improved seed, fertilizers and insecticides) have been found to be poor.

Despite the dire positive impacts reported by surveyed irrigating households the following factors have been mentioned both by irrigating and non-irrigating households which affect the efficiency of the constructed irrigation schemes in both irrigation schemes:

- Investments in intensive horticulture crop production have become a risky business owing to repeated crop failure caused due to prevalence of crop disease and inadequacy of water.
- Lack of regular supply of agricultural inputs, extension services and credit;
- Limited institutional support or linkage particularly in creating market access to their produce and providing technical advice on

agronomic practice and use of agricultural inputs

The survey outcome has also revealed that considerable portion of the households' who have access to irrigation are leasing out their irrigation land for dismal rental arrangement. The major inhibiting factors mentioned by non-irrigating households includes: shortage of money to buy inputs, hire labor and cover water fee, inadequate supply of high yielding seeds, and lack of draught power (oxen) technical skill on irrigation agronomic practices. In essence, the hallmark of these limiting factors is lack of government support in terms of putting in place appropriate institutional and organizational support.

6.2 Recommendations

Based on the above findings of the study, the following implications or concluding remarks can be drawn for further consideration and improvement of irrigation development in the study area in particular and in the region at large.

The target community should receive continuous training and technical assistance on overall irrigation management and agronomic practices. Specially, there is limited diversification in the ranges of cash crops grown in the area. The focus should not only be on the physical achievement of the construction of irrigation schemes, but also on the economic returns that the target community can generate from it and hence, extension strategy that can make efficient use of the schemes should be developed and put in place.

Financial status of the target community is another factor explaining the decision to fully and/or effectively engage in irrigation. In essence, lack of capital to cover key production expenses such as purchase of high yielding variety seeds, fertilizer, pectized and water fee and labor cost were found to significantly influence household's full engagement in the irrigation facilities. This could imply that households largely needed external financial sources to back-up their own financial constraints to meeting production expenses. Hence, for sustainable increase in agricultural output, farming households should get sufficient amount of money so that they can purchase high yielding variety seeds, fertilizer and agro-chemicals. Therefore, to fill this capital deficiency gap, the recently emerging rural financial institutions should be encouraged and strengthen in terms of number and capacity to reach the needy households.

The other limiting factor revealed from the study is lack of institutional support in terms of creating market linkage and providing market information. This is particularly important to small holder farming communities who have little access to market information both in input and out-put market perspecitves.

The pre-assumption that creating access for irrigation facilities to achieve food security of target communities couldn't be a reality as the study revealed that considerable number of households in the irrigation schemes, particularly women headed households, as I have shown, lease out their plots for dismal rental arrangement. This was mainly attributed to lack of coherent institutional and organizational support.

In conclusion, more defined and coherent institutional and organization set up is very essential to achieve the intended objectives of the irrigation development endeavor. More importantly, policies for input supply, technology development, and access to credit facilities, market information and rural extension have to be adjusted to meet the requirements of the target communities in the irrigation systems.

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Annexes:

Annex-1: The survey questionnaire

1. Identification Information

1. Case number..............
2. Name of the irrigation System? 1= Kara 2= Wargba
3. Peasant Association______________________________
4. Location of the respondent's irrigation plot? 1=Head-end 2=Middle 3=Tail-end
5. Name of the household head______________________________
6. Circle respondent's sex: 1= Male 2= Female
7. Wealth status of the respondent: 1=poor 2=medium 3=rich

2. Socio-economic Characteristics of Households

2. A. Socio-Demographic Factors

2.1. Age of the respondent in years: ………..

2.2. The household size……...

2.3. Sex composition of the household: 1. Male(s) ………. 2. Female(s)………….

2.4. Age composition in the household:

Below 15 years........ 15-20 years...........

21 –65 years.......... Above 65 years........

2.5. Educational level of the household head:

1. Illiterate
2. Read and write
3. Elementary
4. Junior secondary school
5. High school complete

2.6. Marital status of the respondent?

Married.........1	Separated................4
Widowed........2	Never married..........5
Divorced........3	

2. b. Resource Endowment of the Household (land, labor, livestock, access to market)

2.7. Do you possess your own land?

1. Yes 2. No

If yes to the previous question:

2.8. Its total area in hectare or local unit: ___________________

If yes to the previous question 2.9:

2.9. The land use pattern:

2.9.1. Area of grazing land ________ (in hectare /local units/

2.9.2. Area of pasture land ________

2.9.3. Area of fallow land __________

2.9.4. Area covered by trees ________

2.9.5. Total area of cropland _________________

2.9.5.1. Irrigable area ________
2.9.5.2. Area under rain- fed__________
2.10. The total number of active labor force in the household? ___________
2.11. Do you have enough labor for your irrigation farm operation?
1. Yes 2. No
2.12. Do you rear livestock? 1. Yes 2. No
2.13. IF yes to the previous question, what domestic animals do you rear?

Type of animal (tick)	Number
Cattle	
Sheep	
Goat	
Donkey	
Camel	
Chicken	

2.14. Oxen ownership?
1=One ox only..... 2= More than a pair..........
3=A pair of oxen..... 4= Have no ox at all.........
2.15. Round trip distance from the main asphalt road (minute) _______, from the market place ___________

2. c. Occupations of the Household
2.16. Main occupation?
Responses: 1= Yes 2= No

S/N	Occupation	Responses
A	Rain fed crop production	
B	Crop production using irrigation	
C	Livestock rearing	
D	Off-farm activities such as wage labor	
E	Others, Specify----------------------	

3. Land Tenure in the Selected Irrigation Systems

3.1. Do you possess your own irrigable plot? 1= Yes 2= No
3.2. If yes to question 3.1, its total area in hectare? ______________________
3.3. How did you get your irrigation land?
1= Inherited from family 4= Purchase
2= Gift from relatives 5= Distribution by the government
3= It is previous holding 6. Others, specify: _________________________
3.4. Do you lease-out irrigable land (**under binding agreement for more than a year**)?
1. Yes 2. No
3.5. If yes to 3.4, area leased out ________________ (in local unit)
3.6. If yes to 3.4, rank the reasons from1=most important, to 5= least important

A. Shortage of oxen...........
B. Shortage of improved seeds...........
C. Shortage of money to buy input.................
D. Shortage of money to hire labor...............
E. Shortage of money to cover monthly water fees
F. Lack of know how on irrigation practice
E. I have plenty of irrigation land...........

3.7. Do you lease-in irrigation land?
1. Yes 2. No

3.8. If yes to 3.7, area leased-in _______________ (in local unit)

3.9. If yes to Q.3.7 again, please rank the following in order of importance to you (from1=most important, to 5= least important)
A. No adequate own irrigable land.....................
B. I have adequate labor..............................
C. Good market opportunity..................................
D. Irrigation is more profitable..............................
E. No other occupation during the dry season...............

3.10. If no to question 3.1, do you have the right to use irrigation land?
1. Yes 2. No

3.11. If yes to the previous question, how do you get access to irrigation land?
Responses: 1. Yes 2. No
A. Leasing in (contract)..................................
B. Sharecropping..
C. Labor exchange.......................................
D. Purchase...
E. Gift...

3.14. Explain the major problems of land tenure in the irrigation system? (If applicable)
1.____
2. ____

4. Irrigation practices

4.1. Are you applying irrigation on your farm? 1= Yes 2= No
4.2. What is the type of your scheme? 1= traditional 2= modern
4.3. Who developed the scheme? 1= community 2= government 3=NGO 4=1&2 5=1&3
4.4. Who is the owner of the scheme?
1= community 2= government 3= NGO 4= 1&2 5= 1&3
4.5. Do you have any specialized training on irrigation? 1= yes 2= no
4.6. For how long (years) you practiced irrigation? __________
4.7. Does the scheme have been constructed with the consent and full participation of the target beneficiaries? 1= yes 2= no
4.8. If yes, in what aspect did you participate?
1= simply attending discussion assemblies about the project
2= attending discussion assemblies and actively expressing feelings, ideas, views, etc.
3= acting as an informant
4.9. Explain the type of contribution you made for the project
1= money 2= labor 3= material 4= land 5= 1&2 6= 1&2&3

7= 1&2&3&4 8= 1&2&3&4&5 9= others ____________________

4.10. What is the type of irrigation scheme that you are engaged in?

1= river/stream 2= shallow hand dug well 3= Deep wells 4= natural pool/pond

5= artificial pond/dam 6= others (specify)

4.11. What type of water delivery system is used from the source?

1= motor pumps using electric power 2= motor pumps using diesel power

3= diversion using gravity 4= others (specify)______________________

4.12. How many households use same irrigation scheme in common? _____________

4.13. How many hectares of your cultivated land are accessible for irrigation? ________

4.14. Do you irrigate all of your irrigable land? 1= yes 2= no

4.15. If not, rank the reasons from 1=most important, to 5= least important?

A. Shortage of oxen...........

B. Shortage of improved seeds...........

C. Shortage of money to buy input.................

D. Shortage of money to hire labor...............

E. Shortage of money to cover monthly water fees

F. Lack of know how on irrigation practice

E. I have plenty of irrigation land...........

4.16. How many times you produce annually by applying irrigation?

1= Once 2= Twice 3= thrice

4.17. What are the major agricultural crops you produce before and after engaging in irrigation? Response 1=Yes; 2=No

Type of crops	Before irrigation (Yes-1/No-2)	After irrigation (Yes-1/No-2)
Sorghum		
Maize		
Teff		
Tomato		
Onion		
Potato		
Cabbage		
Pepper		
Avocado		
Carrot		
Chat		
Coffee		
Forage crops		
Sugarcane		
Mango		
Others, specify		

4.18. Why do you prefer to grow such crops using the new irrigation scheme?

1= better price 2= good production
3= easy to operate 4= high disease tolerance 5= seeds availability
6= others (specify) --------------------------------

4.19. Have you ever faced a problem of crop failure when using irrigation? 1= yes 2= no
4.20. If yes, why? (Circle as many as apply)
1= water shortage
2= crop disease
3= poor irrigation maintenance
4= over flooding of the farm and consequent erosion
5= others (specify) ---

4.21. How many months of the year you are engaged in irrigation activities? ---------------
4.22. Do you have labor shortage in operating your irrigation farm? 1= yes 2= no
4.23. Are you able to apply as much water as you would like to your crops? 1= yes 2= no
4.24. What constraints affect you in using the scheme efficiently? (Put in order of Importance)
1= lack of input financing; 2= unavailability of inputs;
3= shortage of labor; 4= lack of rural access road & high transportation cost
5= conflict in water utilization with users; 6= lack of marketing for produce
7= water shortage; 8= others--------------------------

4.25. Types of crops grown, irrigated area and yield obtained in 2012

Crops	Irrigated area and yield	
	Irrigated area (ha)	Yield (qt)
Cereal		
Vegetables		
Fruits		
Coffee		
Chat		
Others		

5. Irrigation management Practices

5. A. Water Management

5.1. Is there a mechanism of water pricing for irrigation users?
1= no, water is provided as a free service
2= yes, water is provided by charge but does not vary with the quantity of water used
3= irrigation water charge is based on the volume of water used
4= others (specify) -----------------------------

5.2. Do you get enough water for irrigation?
1. Yes 2. No

5.3. If no to 5.1, what do you think are the reasons? Please rank the following in order of importance to you (from 1=most important, to 5= least important)

A. Water scarcity................................
B. Seepage loss...............................
C. Poor coordination of water distribution.........................
D. Water theft..........................
E. I am tail-end irrigator, water does not reach.............................

5.4. If the respondent highlights water scarcity as key problem. Which of the following are important causes for you?

Responses: 1. Yes 2. No
A. Water is captured by up steam traditional irrigators........................
B. Seepage loss.....................
C. Increasing number of users.........................
D. Declining level of water from the source..........................
E. Poor scheduling of distribution......................................
F. Inadequate coordination of water distribution..............................
G. Others, specify___________________________________

5.5. Is there Water User Association? 1. Yes; 2. No

5.6. If Yes to 5.4, what do you feel about performance of WUA committees in the management of water distribution in the scheme?

Responses: 1. Yes 2. No
A. Enough water is not received (adequacy)...................
B. Water is not received when needed (timeliness)...............
C. Water distribution is unfair (equity)...........................

5.7. If no to question 5.4.C, which socio-economic groups consume more water?

Responses: 1. Yes 2. No
A. Farmers with large family size.........................
B. Head-end farmers..
C. Rich farmers who grow perennials...
D. Others, specify____

5.8. What is the major management problems related to water distribution in the irrigation system (if applicable)?

Responses: 1. Yes 2. No
A. Sanctions not imposed against illegal water users.............
B. Rotation does not accomplish equality..........................
C. Rotations are not strictly implemented........................
D. Poor coordination of water distribution by WUAs committee...............

5. B. Conflict Management

5.9. Have you ever faced any conflict over irrigation water?

1. Yes 2. No

5.10. If your answer to question 5.7 is yes, what are the causes?

Responses: 1. Yes 2. No
A. Water theft/down stream conflict................................
B. Shorter time allowed for irrigation water flow...........
C. Competition due to increasing number of water users......................
D. Water use administration problem..............
E. Lack of maintenance
F. Lack of operational skill/training
G. Others, specify----------------------------------

5.11. In your opinion, have your internal by-laws been enforced (in relation to water allocation/distribution/conflict management?

1. Yes 2.No

5.12. If no to the previous question, what are the major reasons? Please rank the following. Number them from1=most important, to 3= least important

A. WUAs committee members are reluctant............................

B. Users do not respect the decisions of the WUAs committee...........

C. Lack of external support in water and conflict management..............

5.13. If WUAs committee members are reluctant (if yes to 5.12 A), why it is so?

Response: 1.Yes 2.No

A. They have no incentive......................

B. Some members do not respect their decisions (resistance).....................

C. Lack of adequate support from local governance and the irrigation agency......

D. Others, specify_______________________________________

5.14. What do you feel about the performance of WUAs committees in resolving conflicts in the irrigation system?

Responses: 1. Yes 2. No

A. They take immediate action on cases ....

B. They suspend cases ....

C. WUAs committee members do not enforce internal bylaws............

D. Conflict management has been improved.........................

E. Don't know......................................

5.C. System Maintenance

5.15. Overall, what is maintenance of the scheme look like?

1=Very good 2= Good. 3=Acceptable 4= Poor. 5= Very poor. 8= don't know. 9=NA/NR

5.16. If maintenance is poor, what do you think are the causes?

Responses: 1. Yes 2. No

A. Poor coordination of maintenance activities (by WUAs committee)...........

B. Poor imposition of sanction on reluctant users.........................

C. Absenteeism of some members on maintenance days……….

D. Reluctance of some members to make labor contributions.......

E. Breaching of canals by illegal water users..........................

F. Siltation........................

G. Animals damage.................................

H. Others, specify_______________________________

5.18. Frequency of maintenance in a year?

Responses: 1. Yes 2. No

A. Once a year........... B. Twice a year.......... C. Thrice a year.........

6. Support services and adoption of irrigation technologies

6. A. Extension support in terms of adopting improved agricultural practices and technologies

6.1. Have you ever participated on extension program for irrigation?

1. Yes 2. No

6.2. If yes to 6.9, what are the extension programs you have participated?

Responses: 1. Yes 2. No

A. Training............

B. Demonstration................

C. Field day............
D. Others specify..

6.3. Is there nearby government/private owned large scale irrigation? 1= yes 2= no

6.4. If yes, do you have any relation with them? 1= yes 2= no

6.5. If yes, what are the fields of your cooperation?

1= field day or demonstration 2= on-farm verification
3= market facilitation 4= input provision
5= others (specify) ---

6.6. Do you have any relation with any research center? 1= yes 2= no

6.7. If yes what advice/support do they provide?___________________________________

6.8. What kind of institutional support do you need in relation to the scheme?

1= organization and management 2= increase the scheme's capacity
3= maintenance 4= others ----------------------------

6.9. Have you ever used improved crop varieties for irrigation?

Responses: 1. Yes 2. No

6.10. If yes to the previous question, which crop variety ever used?

Responses: 1. Yes 2. No
A. Maize.......B. Onion....... C. ground nut.......
D. Potato...... E. Pepper....... F. Sugarcane........
G. tomato...... H. Mango........I. others, specify ____________________________

6.11. If yes to 6.1, from where do you get the seed?

Responses: 1. Yes 2. No
A. Market.......... B. Extension................ C. Research Center........... D. Office of Irrigation......... E. Cooperative............. F. Others, specify___________________

6.12. Do you plant vegetables every year on your irrigation field? 1. Yes 2. No

6.13. If no to question 6.4, what are the factors that account for rejection/discontinuation?

Reasons: 1. Yes2. No
A. No adaptable varieties............................
B. Unavailability of seed every year.............
C. Water scarcity (require frequent watering)...........................
D. Unreliable access to water................
E. Disease..........................
F. Others, specify______________________

6. B. Credit Facilities

6.14. Have you ever used credit for irrigation farming?

1. Yes 2. No

6.15. If yes to the previous question, what are your sources? Response: 1. Yes 2. No

A. Cooperative.......................
B. Local Lenders...............................
C. The irrigation office.........................
D. Others, specify ------------------------

6.16. If no, why? (If no to 6.9)

Responses: 1. Yes 2. No
A. No collateral..................
B. No need.....................
C. No credit supply....................

D. High cost of credit.........................
E. others, specify ---------------------------

6. C. Market

6.17. How do you sell your produce? (Circle as many as apply)

1= take produce to the market. Where? --
2= traders buy from the field. Where do they come from? -----------------------------
3= traders buy from the field. Where do they sell? --------------------------------------
4= contract with an institution. Which? ---
5= others (specify) --

6.18. How far is the market you mentioned from your plot? ------------------kms.

6.19. How do you sell your produce?

1= as an individual; 2= as a member of an informal group
3= as a member of cooperative; 4= others (specify)-------------------------

6.20. Do you face a problem in selling your produce? 1= yes 2= no

6.21. If your answer is yes what type of problems?

1= low price 2= lack of transport
3= low demand for the produce 4= others (specify) -------------------------

6.22. How are the prices of your agricultural products at local markets during harvest season?

1= very cheap 2= cheap 3= competitive 4= expensive

6.23. What are the prices of your agricultural products at local markets during the non-harvest periods?

1. Very cheap, 2. Cheap, 3. Competitive, 4. Expensive

6.25. Is there any effort by local government in creating market access to your produce?

1. Yes 2. No

7. Benefits of Irrigation

7.1. The positive impacts of irrigation that you have seen (If applicable)?

Responses: 1. Yes 2. No
A= Change in the number of meals eaten per day--------
B= Change in the type and variety of food eaten---------
C= Change in the amount of money spent on education, health, clothing, etc------
D= Change in the ability to cope with draught-----------
E= Change in coping strategies during times of food shortage---------
F= Reduce in crop failure and increase production----------
G= Change in the amount of products sold for income-----------
F= Increased employment opportunities ....

7.2. What are the contributions of diversification to your livelihoods? (If applicable)

Responses: 1. Yes 2. No
A. Increased income......................................
B. Decreased fluctuation in food production....................
C. Increased production per unit area..
D. Others, specify____

7.3. Household net income from participating in irrigation in 2012

Income source	Total income earned (Birr)

Income source (code): Select the codes and fill in the first column

Sales of vegetables = 1
Sales of cereals = 2
Sales of sugarcane = 3
Sales of mango = 4
Sales of chat = 5
Rent of own irrigable land =6
Sales of livestock = 7
Off-form income =8
Others, specify_________ = 9

7.4. Productive assets created through income from practicing in the constructed irrigation schemes?

Productive asset (Code)	**Performance (Number required)**

Productive assets: fill the relevant (to the respondent) codes in the first column

Oxen = 1
Donkey = 2
Sheep = 3
Goat = 4
Cows = 5
Agricultural equipment (watering can, ploughs...etc) = 6

7.5. If you hire labor, what was the number of wage laborers you employed in 2011? (If applicable)

1. Permanent labor___________________ and total cash paid............
2. Causal laborers ___________________ and total cash paid.............

7.6. Rank the following important factors which most inhibits your irrigated production at present

Factor	Rank	Extent of the problem		
		Simple	Modest	Considerable
Water				
Land				
Input				
Credit				
Market				
Transport				
Crop Damage				
Competition				
Absence of government support				
Lack of skill				

Annex-2: Checklist for key informant and focus group discussion

1. Checklist for key Informant Interview

- Major crops grown before and after intervention?
- What are the existing irrigation land leasing out mechanism and how those mechanism works?
- What are indicators for wealth ranking according to the local standards?
- Working days/ calendar of farmers i.e. what they do during different months, during wet and dry seasons
- Compatibility of irrigation with the farming system and socio-economic and socio-cultural environment
- Major institutional and management problems in the irrigation systems
- Formal and informal institutions of land tenure and water rights in the irrigation systems and their problems

2. Checklist for Group Discussion (with irrigators)

- How do you view the relevance of the constructed irrigation schemes in terms of existing socio-economic status, livelihood pattern and institutional set up?
- Farmers' perception about benefits of irrigation and its sustainability: Do the constructed irrigation schemes pay-off in terms of improving household’s food security?
- Is there WUA committee with in the irrigation schemes? How do you evaluate their organizational structure, management performance and their overall functioning?
- Water management in the irrigation systems: Water allocation and distribution
- Major problems in water management or principal areas of users' complaints.
- How do you perceive the strength of existing bylaws and enforcement characteristics
- Supports given from the local Irrigation Office and local governance
- Conflict and conflict management in the irrigation systems
- Land tenure and water rights in the irrigation systems

- Support services; Credit, input(seed) and extension
- Technical problems of the irrigation schemes
- Socioeconomic viability of the irrigation intervention: Compatibility of irrigation with the farming system/socioeconomic environment (market, family labor allocation and choice of crops, etc.)
- What are the major constraints of irrigation farming and the irrigation systems

3. Checklist for Interview to Institutions

- Socio-economic profile of the study area (WOFED)
- Background of irrigation development in the area
- Irrigation Development and available support institutions in the area
- Historical development/background of the two irrigation schemes
- Type of irrigation schemes in the project area and total number of irrigation schemes being functional;
- How do you view community acceptance and application of the constructed irrigation schemes
- What do you think are the major reasons for households to lease out their irrigation land for dismal rental fees?
- What follow up action have you planned to encourage households to engage and fully harness the benefits from participating in irrigation using the constructed irrigation schemes?
- Organization of users for self management: organization, performance and constrains
- Land tenure and water rights and their implication on management and utilization of the schemes
- Stakeholders, their expected roles, linkage, performance and constraints
- Water management in the irrigation systems
- Major management and sustainability constraints
- Institutional capacity of the irrigation agency: organization, capacity and effects of institutional instability
- Prevailing policies and strategies for SSI development
- Service provision for irrigation: credit, input and extension
- Performance of WUAs in managing conflict
- Supporting activities of the irrigation desk to WUAs in irrigation management
- Major problems in the irrigation systems as they see them
- Available technologies that work under irrigation and on-going research on irrigation?

4. Checklist for Interview to WUA Committee

- Profile, structure/organization, constraints, bylaws and their enforcement

5. Checklist for Group Discussion with Women Farmers

- Participation/membership to WUA, access to irrigation land, water and services