Assessment of Effectiveness of Small Scale Irrigation Schemes: Case Study of Batu Degaga Irrigation in Central Oromia

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DEVELOPMENT STUDIES

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Acronym

ADP	Area Development Project
ADLI	Agricultural Development Led Industrialization
AEC	Associated Engineering Consultants
AMARC	Awash Melkasa Agricultural Research Centre
BC	Before Christ
CRDA	Christian Relief Development Association
CIS	Corrugated Iron Sheet
CSA	Central Statistical Agency
CTA	Technical Centre for Agricultural and Rural Cooperation
EBR	Ethiopian Birr
EEA	Ethiopian Economic Association
FANTA	Food And Nutrition Technical Assistance Project
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
FFW	Food for Work
GPS	Geographic Positioning System
IDCOF	International Development Consulting Firms
IDD	Irrigation Development Department
ILRI	International Livestock Research Institute
IPTRID	International Program for Technology and Research in Irrigation and Drainage
IWMI	International Water Management Institute
MDGS	Millennium Development Goals
Masl	Meters Above Sea Level
MI	Micro-Irrigation
MOA	Ministry of Agriculture
MoWR	Ministry of Water Resources

NGOS	Non-Governmental Organizations
OIDA	Oromia Irrigation Development Authority
ONREPB	Oromia Natural Resources and Environmental Protection Bureau
OWMERDB	Oromia Water Mineral and Energy Resources Development Bureau
OWWCE	Oromia Water Works Construction Enterprise
OWWDSE	Oromia Water Works Design and Supervision Enterprise
OandM	Operation and Maintenance
OLS	Ordinary Least Square
PRSP	Poverty Reduction Strategy Paper
RWH	Rain Water Harvesting
SD	Standard Deviation
SEAGA	Socioeconomic and Gender Analysis
SNNP	South Nations and Nationalities People
SPSS	Statistical Package for Social Sciences
SSI	Small Scale Irrigation
TLU	Tropical Livestock Units
WUA	Water Users Association
WV	World Vision
WWDSE	Water Works Design and Supervision Enterprise

Abstract

In spite of the significant contribution of small scale irrigation towards food supply and employment creation there are enormous factors that challenge efficiency as well as their effectiveness.

The purpose of this study is to identify major constraints for the effectiveness of existing small scale irrigation schemes based on Batu Degaga Communal Small Scale Irrigation in the upper Awash valley.

The study employed both qualitative and quantitative methods of data generating and analysis techniques.

In the study it was found that 57.1% of the targeted area is not totally irrigated because of deficiencies in planning and designing that didn't take into account the topography and pump capacity to deliver sufficient water.

Binary logistic was applied together with descriptive methods to analyze the survey data in identifying and measuring household level determinants of effectiveness of small scale irrigation schemes. The model categorized improved irrigators and not improved irrigators due to the irrigation project in 86% of the cases correctly. Out of the 16 hypothesized variables ten of them increased the probability of improvement of household's living standard after irrigation as expected. Four of the variables including number of oxen possessed by families and level of output from rain fed production are found statistically significant. Proper planning and designing of small scale irrigation is paramount. Emphasis has to be given for land preparation. Provision of credit service for purchase of inputs and covering expenses related to irrigation practice are areas of intervention.

1. INTRODUCTION

1.1. Background

Incompatibility of growth in food production and population coupled with occurrence of drought has become a challenge to the livelihoods of millions of people especially in the south of the globe. Unreliability and recurrent rainfall has constrained crop production that totally depends on rain fed agriculture.

Utilization of water resources for agricultural development is the main strategy adopted by nations to narrow down the existing gap between demand and supply for food crops. Irrigation practices do not only raise household food consumption but also increase household income and hence significant impact on household food security.

According to FAO (1996) Irrigated agriculture has made a major contribution to food production and food security throughout the world and much of the impressive growth in agricultural productivity over the last five decades could not have been achieved with out irrigation.

Globally irrigated agriculture provides 40% of the total food supply (Hermiteau, 2003).In Ethiopian context the contribution of irrigated agriculture to the total food supply is estimated to be about 3% (IDCOF, 2002).

In response to an average 3% annual population growth, and the fact that rain fed productivity become unreliable, irrigation development is a major solution in terms of food security and alleviating rural poverty predominantly in arid and semi arid parts of Ethiopia. The ADLI and strategy of the country which basis it self on rural development also gave due attention to the development of water resource in boosting agricultural production and productivity.

Certain groups of crops mainly vegetables are supplied to local markets from irrigated fields. The employment generated by irrigation practices is also considerable including product distribution and marketing.

Based on analysis of the water resource development master plan prepared for major river basins, the total irrigated area so far in Ethiopia was 4-6% of the potential land for irrigation (IDCOF, 2002; MOWR, 2002). This indicates that little is done in using the water resource for the agricultural development in particular and socioeconomic development of the country in general.

In the Agricultural Development Led Industrialization (ADLI) policy it was emphasized that smallholder's irrigation development is seen as the country's main development strategy to improve the problem of food security and to maintain the overall growth of the rural economy (Lema, 2004).

1.2. Statement of the problem

Despite the significant contribution of irrigated agriculture towards food production and consumption the efficiency of existing small scale irrigation schemes is not as anticipated at the planning and appraisal stages.

For instance Past World Bank review of its experience with irrigation investment projects found that of 208 Bank funded irrigation projects evaluated only two-thirds have satisfactory outcomes (FAO, 1996). Even those projects rated as satisfactory indicated a substancially lower economic rate of return at evaluation(average 15%) than expected at appraisal (average 22%)(FAO).

It was indicated that donors have lost interest in irrigation development in Sub-Saharan Africa, pointing out its lack of market competitiveness with other alternative uses of water caused by the resultant effect of low prices for major cereal crops and its cost effectiveness in the 1980s (Hermiteau, 2003).

In contrary to the above statement currently there is an increased demand for agricultural products in the world market which can make irrigation a profitable endeavor. Thus improving irrigation performance (Sustainability and profitability) is a crucial issue for bringing back investment to the irrigation sector on the one hand and maximizing positive impacts of the existing irrigation activities on the other hand.

Small scale irrigation schemes implemented in 1980s face the problem of poor performance as that of large schemes run by the state in Ethiopia (Desalegn, 1999). According to one assessment conducted by a group of professionals the overall performance of 96 implemented projects in Oromia considering area targeted for irrigation versus actually irrigated area is estimated to be

58%. Similar figure was estimated for the targeted beneficiaries versus those actually participated in the development (JICA/Nippon Koei, 2003).

The majority of the evaluated schemes are river diversion with limited number of pump schemes. The problem associated with management of pump schemes is more complicated compared to gravity system.

There are technical and socioeconomic factors that determine effectiveness of small scale irrigation schemes. This study is going to investigate these factors with special emphasis to social and household level determinants of effective performance of small scale irrigation schemes based on Batu Degaga project in the upper Awash Valley.

1.3. Objectives

The general objective of this study is to identify major factors that determine effectiveness of small scale irrigation schemes in Adama district based on Batu Degaga project.

Specific objectives

- To study household characteristics and other socioeconomic determinants of irrigation practice
- To study the contribution of irrigation practices towards household food security and income generation in the study area
- To study major problems associated with running pump schemes with emphasis to using common property

1.4. Research Questions

What are the major determinants of effectiveness of Batu Degaga small scale irrigation scheme?

What is the contribution of irrigation practice in the livelihood of the community?

What are some of the technical factors which can contribute towards effectiveness of small scale irrigation schemes?

What are the household level determinants of small scale irrigation practice?

What measures are required to improve the performance of existing small scale irrigation schemes?

1.5. Significance of the study

Knowledge of factors determining efficiency of performance of water development activities in general and irrigation in particular is crucial for future planning of development projects that are geared to wards alleviating rural poverty. If major constraints for irrigation performance are identified unnecessary costs can be minimized and resources can be used efficiently and optimally. Policy makers and irrigation planners can benefit from the identification. In general reasonable projects can be prepared and implemented. The study also paves the way for other researchers to do more comprehensive research in the area.

1.6. Conceptual Frame work

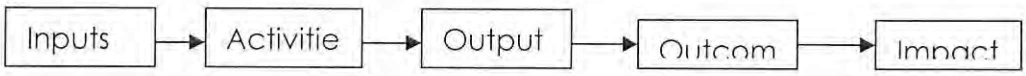
1.6.1. Concepts of Effectiveness and Measurement

Although the concept of effectiveness is not new, some people tend to confuse efficiency and effectiveness. The difference between effectiveness and efficiency is that effectiveness is the extent to which the outcomes of an activity achieve the stated objectives, while efficiency is the extent to which the use of inputs is minimized for a given level of outputs (Australian Office of Taxation).

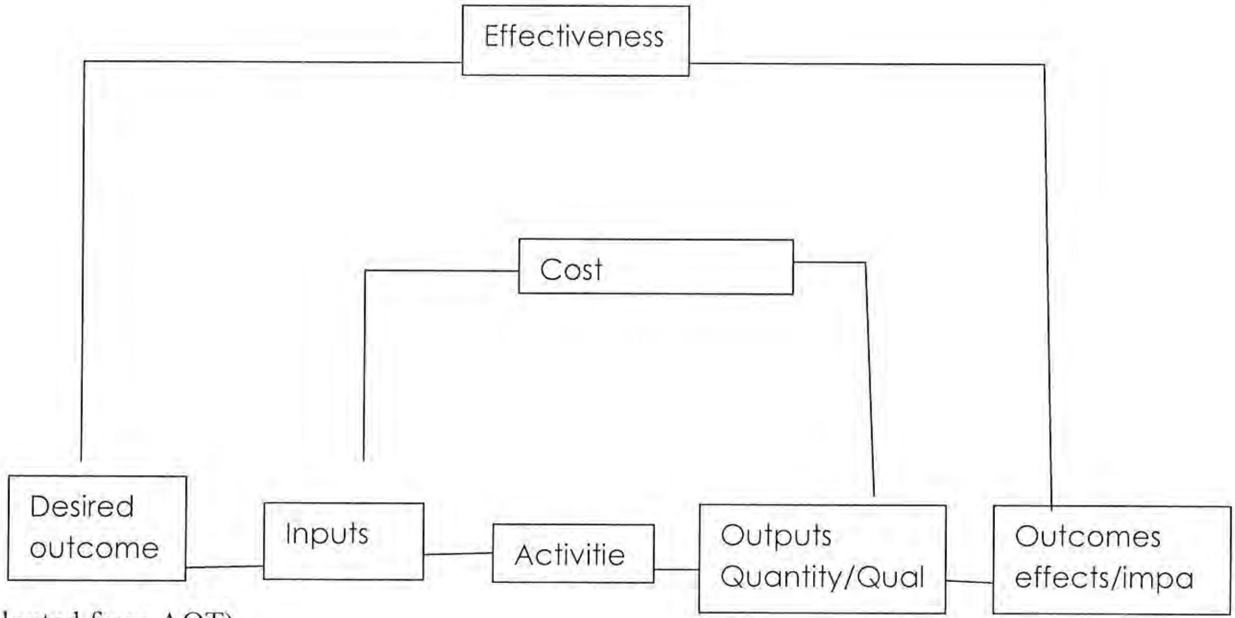
Measures can be categorized based on the type of system they represent. These types include task,process and object measures. Task measures compare plan versus actual performance. Process measures on the other hand ,are typically used to monitor productivity against a predefined standard ,benchmark or goal (Rechard, 2006).

Effectiveness measures provide decision makers feed back on the impact of deliberate actions and affect critical issues such as allocation of scarce resources, as well as whether to maintain or change existing strategy and the purpose of effectiveness measurement is to obtain objective information for use in strategic decsion making (Rechard, 2006).

One of the models to describe effectiveness is logic model. The following is a simplified logic model which is adopted from Australian Office of Taxation (AOT).



Expanded program logic Model



(Adopted from AOT)

From the flow diagram efficiency (cost effectiveness) measures assess the relationship between outputs and inputs used to produce them. Cost effectiveness measures evaluate outcomes as a proportion of the total inputs required to produce them. Effectiveness measures assess the whole sequence in terms of how it achieved the intended objectives or outcomes.

According to Sproles (1997) in Rechard (2006) a measure of effectiveness concerns how well a system track against its purpose or normative behavior. However Sink (1985) mentioned in Rechard (2006) described a measure of efficiency or a measure of performance as how well a system utilizes resources.

1.6.2. Effectiveness of irrigation

Effectiveness of Irrigation refers to benefit earned from irrigation by the target communities or beneficiaries in a broader sense that can be explained in terms of the change in the quality of life of rural households. Change in quality of life in turn can be explained by better housing, increased number of meal with quality, asset possession in terms of livestock and other household equipments.

Effectiveness of irrigation can be measured by comparing proposed area to be developed and that actually developed. Imbedded in is total quantity of outputs of different crops planned and actually produced by the irrigation system. Similarly the initial targeted beneficiaries at the design phase and those actually involved in irrigation can be used to measure some constraints for effective irrigation performance.

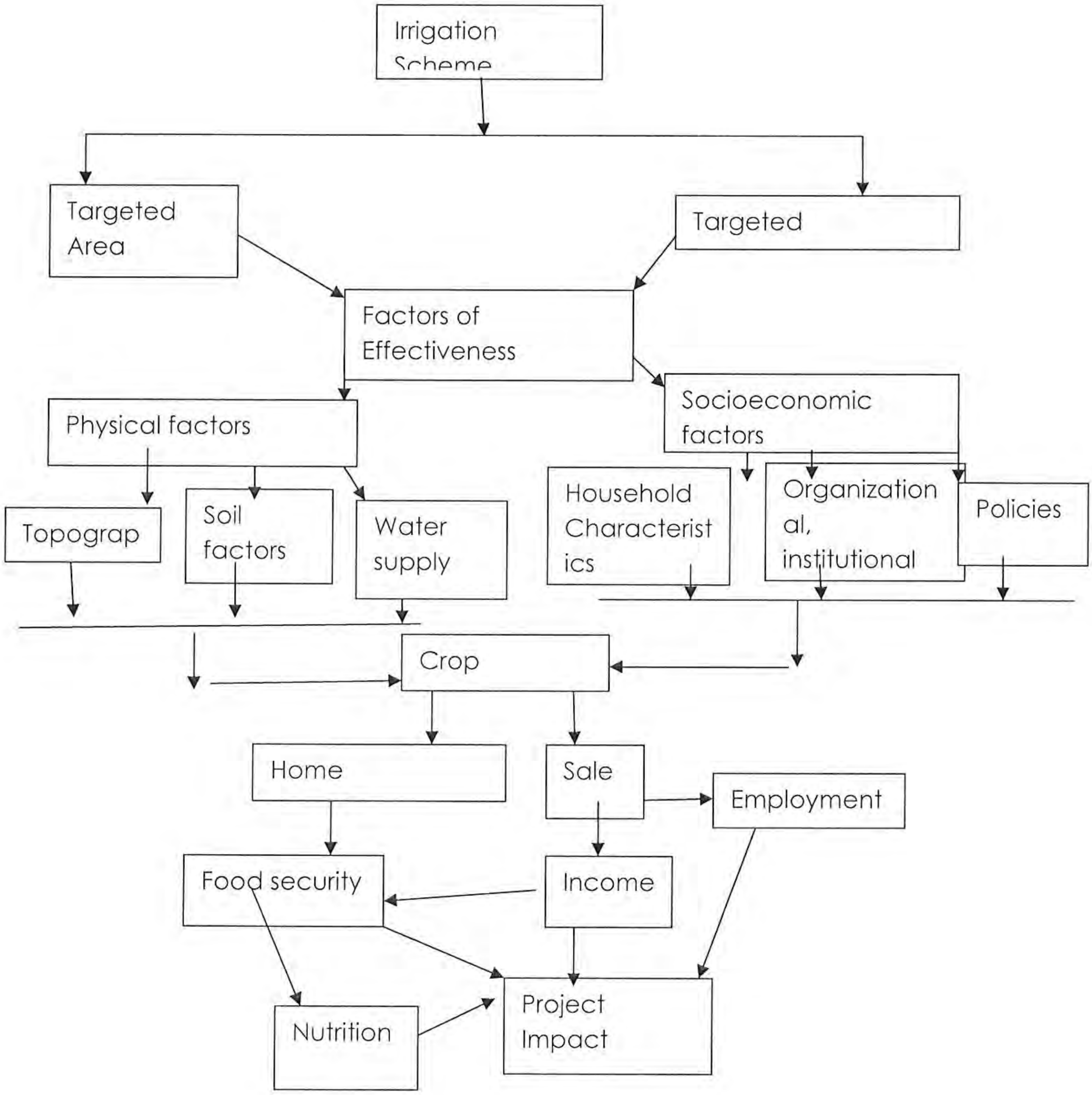
World Bank Investment Centre has used economic and financial rates of return to measure performance of its funded projects in addition to other qualitative measures such as social and environmental indicators (FAO, 1996).

Other studies try to estimate the contribution of irrigation schemes towards food security and estimate net benefits generated by irrigation schemes and assess some constraints associated with them (Mengistu, 2008; Wagegnew, 2004; Yusuf, 2004). (Weldeamlak,2007) used proportion of technology adopters and benefits earned to measure effectiveness of Rain Water harvesting technologies.

The above studies used aggregate figures which could not enable us to identify factors contributing for the effective performance of water development technologies in rural areas across the participants. These studies and others identified many constriants for effective performance of small scale irrigation schemes. However there are no systematic relationships established between different factors that take part in irrigation development despite the fact that social scientists do employed various logistic models specially in areas of technology adoption and changes in income because of development interventions. On the other hand relying on calculating net benefits may not be good indicators because of difficulty of getting reliable data. For instance economic and financial rates of return require timeseries data indicating cash in flows and outflows by every participating household which is difficult to get such data in the context of developing countries. They indicate prifitability or viability of projects by sidelining the factors for the success or otherwise of the projects.Similarly proportion of adopters could not tell us reasons for adopting and not adopting the technologies explcitly.

In this study the effectiveness of the scheme was measured at two levels. First at project level the area and beneficiaries targeted at the planning and designing stage are compared and contrasted with the actual developed area and beneficiaries that are actually using the scheme to study factors of effectiveness. Secondly improvement in the living standard of the irrigators due to irrigation practice was used as a proxy to study some factors of effectiveness at household level. Household characteristics and socioeconomic attributes are emphasized in this case.

Schematically the contents are depicted as follow.


Irrigation
Scheme
Targeted
Area
Targeted
Factors of
Effectiveness
Physical factors
Socioeconomic
factors
Topograp
Soil
factors
Water
supply
Household
Characterist
ics
Organization
al,
institutional
Policies
Crop
Home
Sale
Employment
Food security
Income
Nutrition
Project
Impact

1.6.3. Hypothesis and Definitions of variables

Dependent variable:

Improvement in the living standard after participating in the irrigation project is the dependent variable. It is explained by change in quality of life after the project. Respondents are asked to explain their living standard roughly before and after implementation of the project. This can be gauged simply by assessing condition of food availability and possession of major assets such as housing, household utensils, livestock and cash holding. If the respondent perceives improvement by weighing the above indicators his livelihood is considered being improved after irrigation and otherwise. The response may be his living standard has been improved, remain the same, worsened or unknown.

Explanatory variables

The following variables are hypothesized to be factors of effectiveness of irrigation practice at household level.

*Sex of the h*ousehold Head (SEXHH): it refers to whether the head of the household head is male or female. This variable is very important not only because of female headed household lack labor for irrigation practice, but also gender differentiation in terms of access to water and irrigation land. It is hypothesized that male headed households could benefit more from irrigation practice compared to their corresponding female headed households.

Age of the household Head (AGEHH): it refers to ages in years of family head. It is hypothesized that this variable is positively related with benefit from irrigation because of longer experience in agriculture in general and irrigation practice in particular. On the other hand the young groups lack access to land and water resources because of limited land distribution made so far with the increased young householders in rural areas.

Active labor force in the family (ACTIVELA): It refers to number of economically active members of the family (10-65) and it is expected to be positively related with benefits from irrigation practice and improvements in livelihoods of the participants. As the number of active family members increases benefit from irrigation is expected to increase since irrigation is labor intensive technology.

Family Size of the household (FSIZE): This refers to total number of persons in a family. This variable is expected to result in no improvement from irrigation especially if the proportion of dependants is significant in a family.

Education of the household head (EDUCATIO): This refers to educational status of head of the family and expected to be positively correlated to the benefits from irrigation. As the number of years at school increases the gains from irrigation is expected to rise since the impact of science and technology is considerable on production and productivity.

No of oxen owned by the family (OXEN): it refers to the number of oxen owned and it is assumed that households may not face problem of traction power and benefit more from irrigation practice.

Number of livestock in TLU (LIVETLU): it refers to non-oxen number of domesticated animals owned in tropical livestock units (TLU). It is hypothesized that the more TLU a family has the better are households in a position to afford expenses related to irrigation practice and benefit accordingly.

Total output (PRODUCTI): it refers to the quantity of out put from rain fed field. This variable is also expected to be positively related with irrigation because more production and income increases the opportunity to afford expenses related to irrigation practice such as purchase of inputs and the like.

Size of irrigation plot (IRRIGATI): this is size of irrigation plot in the target area. It is expected to be positively related with gains from irrigation practice.

Quantity of fertilizer purchased (QUANTFER): It refers to the quantity of chemical fertilizer purchased and applied to all crops be rain fed or irrigated and it is expected to increase the gains from irrigation practice. It indicates the respondent's capacity and willingness to use modern farm inputs.

Quantity of Chemicals purchased (QUANTCHE): refers to amount of chemical purchased and applied to crops and it shows households status to afford costs of crop protection and maximize benefits from irrigation practice.

Identified number and type of farm equipments (FARMTOOL): This is the type and number of farm tools possessed for different activities of irrigation practice and is expected to increase gains from irrigation.

Sufficient Output From rain Fed production (Suffout): This refers to whether the out put from rain fed field with out irrigation is sufficient or not. It is hypothesized that if it is not enough the impact of irrigation for such households is significant. So it is a dummy variable and given a value of 1 if the respondent do not produce sufficient output using rain fed and 0 if he produces sufficient output.

Participation during project planning (PARTI): This variable refers to the involvement of the respondent during planning and implementation and it is expected that this variable to a large extent affects the successful performance of the scheme and hence improvement or other wise of the respondents livelihood because of irrigation.

Plot Management (OWNMGT): whether the plot in the target area is self managed or leased out with other arrangements. It was hypothesized that households who manage them selves generate good benefit compared to those who lease out their plots. This variable is categorical and given a value of 1 if self managed and 0 otherwise.

Degree of Effectiveness of public services (DEGREFFE): this variable is the resultant of five variables measured on scale. These are access to market information, availability of credit service, access to agricultural inputs, getting advice on water management, training on pump operation. It is hypothesized that access to effective public services in this case extension and others increases the benefit earned from irrigation. A value of one is given if the respondent attains a value of 2 and 1(good and very good) in three of the variables and 0 otherwise.

1.7. Organization of the thesis

The rest of the paper is organized as follow. Section two is reviewing the literature. Related articles and materials related to irrigation development are provided. Section three describes geographical and administrative location of the study area followed by the methodological approach. The agricultural potential and farming system of the study area is also included in this section. In section four the analysis and interpretation of results was provided. The last is section five and it is the conclusion. Here main points are further elaborated and some policy lessons are forwarded.

2. Literature Review

2.1. Definitions and Concepts Related to Irrigation Technology

Irrigation is defined as the process by which water is diverted from a river directly or after storing in a dam or pumped from a well or a combination of diversions and pumping so that it is used for the purpose of agricultural production (Sileshi, 2001). The water used for irrigation is taken from lakes, rivers, streams and wells. If the farm lies at a lower elevation than the supply source the water flows to the canals by gravity otherwise the water has to be pumped to the canals (World Book Inc., 1994).

Irrigation is not simply a technical task of delivering water to crops. It is also a human activity and social undertaking because rural households operate within a larger historical, socio-cultural, economic, institutional and policy environment (Lema, 2004). This is why we need to study the problems associated with irrigation practice not only from technical point of view but also from social dimension as well.

2.2. History of Irrigation

The start of irrigation agriculture goes as far back as 5000 years. Early civilization along the major rivers in the world is thought to have a close relation with irrigation (Ameha, 1986). Archeological investigation has identified evidence of irrigation in Mesopotamia and Egypt as far as back as the 6^{th} millennium BC, where barely was grown in areas where the natural rainfall was insufficient to support such a crop (www.wikipedia.org).By the middle of 20^{th} century the advent of diesel and electric motor led for the first time to systems that could pump ground water out of major aquifers faster than it is recharged. (www.wikipedia.org)

According to Kloos (1990) irrigation in Ethiopia probably predates the arrival of the Semitic speaking immigrants from Yemen and possibly agriculturalists from Sudan. Both groups may have introduced seed/plough cultivation and irrigation to Northern Ethiopia in the area of the later Axum Empire between 1000 B.C. In the 15^{th} and 16^{th} centuries, the Portuguese missionaries Alvarez and Almelda reported the use of irrigation in various localities in the Northern high lands, and among the Afars in the lower Awash Valley (Kloos, 1990).

2.3. Sources and Types of Irrigation

Irrigation water is withdrawn from a water source (river, lake or aquifer) and led to the field through an appropriate conveyance infrastructure (FAO ,2003).

There are various types of irrigation techniques which differ in how the water obtained from the source is distributed within the field. Based on this irrigation techniques can be surface irrigation, localized irrigation including sprinkler and drip irrigation. The third category is manual using buckets and water cans. (www.wikipedia.org)

Irrigation can be also classified as gravity irrigation and pumped irrigation based on the type of energy that operate. The former mainly involves river diversion and is common type of irrigation in Ethiopia. It is preferable than the later since it is locally manageable technology and entails no running energy cost in terms of fuel or electric power.

Most literatures (IDCOF, 2002; Desalegn, 1999; Tahal Consulting Engineers LTd, 1988) classify irrigation practices as large scale, medium scale and small scale based on magnitude of area developed. Large scale and medium scale schemes are mainly managed by government enterprises mainly for growing fruits and sugar plantations in Ethiopia. These are mainly concentrated in the Awash River valley in Ethiopia.

Small scales can be also traditional and modern. In Ethiopian context, small scale irrigation accounts for about 40% of the coverage according to WWDSE (2000) in IDCOF (2002). It was described that traditional irrigation as those schemes that have been initiated and constructed by farmers using the knowledge and resources available to them. Farms under traditional irrigation are in many instances, characterized by temporary diversions/ structures and channels not built following formal engineering designs and as a consequence, may not contain optimum grades and cross-section (Tafese, 2003). These schemes are constructed by local people using simple intake structures such as soil bands and stones along rivers and streams. In Ethiopia most traditional schemes are associated with water mills. Traditional schemes are under gradual transformation into modern schemes by the actions of different agencies.

2.4. Modern Small Scale Irrigation

The standard given to classify irrigation schemes based on magnitude vary from country to country and region to region. For instance what is large scale in African countries may not in Asian countries. In Ethiopian context the general agreed up on classification is as follow. Small scale areas covered less than 200ha; areas between 200 and 3000 are classified as medium and those beyond 3000ha are categorized as large scale. According to Turner (1994) cited in Yohannes (2004) small scale irrigation is irrigation on small plots where farmers have the majority control, using technologies which they can effectively operate and maintain. They can be traditional which are initiated by the local communities themselves or modern communaly owned schemes which are upgraded or developed by governmental or non-governmental agencies. They can be also privately operated schemes.

During the 1980s the awareness of the failure of large-scale projects increased the interest in, and the tendency to promote, small-scale irrigation (Smout 1994; Turner 1994) as mentioned in Yohannes (2004).

According to Vaishnav (1994) in Yohannes (2004) the preference for small-scale schemes is based on the perceived easy adaptability of the systems to local environmental and socioeconomic conditions.

The recent shift in paradigm of development from past top down approach to bottom up and grass roots level is mentioned to be one of the reasons for the popularity of small scale irrigation schemes.

Small scale irrigation was favored over large commercial schemes by the Ethiopian High lands reclamation study and the government implemented a peasant irrigation program in response to the 1984/85 famine (Kloos, 1990). Naturally, small-scale irrigation development does not require huge capital investment and highly skilled man power (Ameha ,1986).

The impact of these schemes on food security and alleviating rural poverty was also considerable. Community managed small-scale irrigation systems, by improving yields and cropping intensities have proved effective in alleviating rural poverty and eradicating food insecurity (FAO 2003). It has been estimated that small scale irrigation in Ethiopia can increase agricultural production by 5% at most although its potential contribution may be significantly greater in more arid low land areas (Kloos H. , 1990).

2.5. Irrigation and Food Security

Food security is defined by FAO (2003) as physical, social and economic access for all people to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Its converse, food insecurity, applies when people live with hunger and fear of starvation (FAO 2003). According to this source food security requires that:

- Sufficient quantities of food of appropriate quality be available- a production issue;
- Individuals and households have access to appropriate foods- a poverty issue; and
- Nourishment is taken under good conditions, including regular meals, safe food, clean water and adequate sanitation- a public health issue

Irrigation is basically an agricultural activity, which is directly relevant to food production and security (IDCOF, 2002). Irrigation if well targeted might solve part of food security problem, which is the main goal for improving water use efficiency (Bello.W.B., 2008).

The case for continuous support for irrigated agriculture is a very strong one and the current consensus among policy makers in the developing world is that irrigated agriculture has a major role to play in meeting the MDGS (Cogels, 2003). Irrigation plays a significant role in achieving sustainable food security if properly planned, developed and managed since it can provide water whenever and wherever it is needed to reduce moisture deficit (IDCOF, 2002;Geremew,2007).

World irrigation has grown from 8million ha in 1800 to 275million ha today and now produces over 40% of the worlds food and fiber needs and 60% of cereals (Cogels, 2003). In 1998,irrigated land made up about one-fifth of the total arable area in developing countries but produced two-Fifths of all crops and close to three-fifths of cereal production (FAO, 2003).

Out of a total area of 212 million ha under cultivation in Sub-Saharan Africa an estimated 5.1million ha (2.4%) is under irrigation, but this supply 10% of the agricultural production (FAO, 2003). This implies that very little is done to alleviate the food insecurity and poverty in the region by using the potential water resource.

It was explained in the Water Management policy of Ethiopia that if the country's water resources are developed to cater for irrigation, it would be possible to attain agricultural surplus enough both for domestic consumption as well as for external markets (MoWR, 2002). Droughts occur every 8-10 years for the whole country with severe consequences of production. The government of Ethiopia as stated in its Poverty Reduction Strategy Paper (PRSP),the importance of water and increased its focus on water resources development and utilization to achieve food security (FDRE,2000) in Ersade (2005). Its water policy stresses increased use of small –scale irrigation through diversion of rivers and building of small dams.

Using the stochastic production frontier approach, it was concluded that irrigation development in Ethiopia is a viable development strategy but attention needs to be paid to improve the technology available to farmers under both rain fed and irrigated production (Godswill, Dawit, and Dejene, 2007).

Kloos (1990) concluded that success of any SSI program in Ethiopia, in regard to contributing to food security on a sustained basis, will depend to a large degree on:

- The ability of the governments economic policy to create motivated farmers and facilitate their participation
- The appropriate mix of farmers initiatives and government support structure

2.5.1. Irrigation and Population Pressure

World population is expected to grow by a further 30% in the next 25 years, mainly in developing world where water is in short supply (Cogels, 2003). More than 1.3 billion people do not have access to enough food at household level and the problem is growing (Cogels,2003). Many live in dry and drought prone areas where the main livelihood depends on water and agriculture. (Cogels) According to FAO (2003) the focus of irrigation development is expected to be concentrated on the group of developing countries where demographic growth is strong. Irrigation offers the potential to absorb excess labor caused by population increase in rural areas. For instance in Bangladesh about 12 million acres of single- cropped area can be brought under double triple cropping resulting in increased demand for farm labor (Emmanuel and Kaye, 1997). The productivity boost provided by irrigated agriculture results in increased and sustained rural employeement, thereby reducing the hardships experienced by rural populations that might otherwise drift to urban areas under economic pressure (FAO ,2003).

At the current rapidly growing population and the declining arable land, the elimination of chronic food insecurity is highly linked with the use of productivity increasing technological innovations (Setotaw, Gezahagn, and Haylemariam, 2004). Irrigation could be one of these technologies.

It was estimated that if the average employment coefficient of irrigated farms is 4 man-years per hectare and if the total potentially irrigable area becomes irrigated, irrigation agriculture will have the ability to employee 24% of the total population or a larger proportion of the active labor force in Ethiopia (Ameha , 1986).

The Ethiopian High land Reclamation Study concluded that intensive agriculture including irrigation in addition to land rehabilitation and resettlement of peasants from the chronic famine areas is essential to assure food security for the growing population (Kloos, 1990).

2.5.2 Poverty and Unreliable Rainfall Patterns

Poverty in Sub-Saharan Africa is primarily a rural phenomenon. About 70% of the poor live in rural areas, where agriculture is their main stay. Low productivity of agriculture and strong dependency up on highly variable rainfall render poor people extremely vulnerable to risk (FAO, 2003). In Sub-Sahara food security and income of rural population are vulnarable to rainfall variability , and food production is often less than the requirements of the growing population (Debere, 2006). Droughts periodically affect different parts of semi-arid areas and often come in runs of two to five seasons. Crop failures every fifth year are a reality, and the risks of yield reductions due to water constraints are high every second year (FAO, 2003).

In countries where irrigation farming constituted very small proportion of crop land, the amount and variability of rainfall ,no doubt affects agricultural production severely (Mesay, 2001).

One of the major factors contributing to food insecurity in Ethiopia, particularly to transitory food insecurity is the dependency of agriculture on a highly variable and unreliable rain fall (Weldeamlak, 2007). This together with decreasing arable land holding per household, made irrigation to gain importance over recent years.

Sileshi(2001) using multiple input stochastic models found that a 10% decrease in mean annual rain fall amounts other input varaibles being constant results in a 3.8% decrease in national cereal production.

In the National Water Sector Development Program of Ethiopia it is indicated that water can be made to contribute to the national economy through the development of the country's water resources and expanding irrigation schemes so that agricultural production is improved by solving the problem of water shortage caused by the unpredictability of rainfall (MoWR, 2002).

In general it was indicated that the declining productivity in rain fed agriculture and the need to raise food Production increased the need for expansion of effective and efficient irrigation systems.

2.6. Constraints of Effective Irrigation Performance

The challenge that irrigated agriculture faces in the coming years is: How to increase water productivity in the face of growing water scarcity and the limited availability of water for agriculture. The existing implemented small scale schemes are not functioning smoothly. There are varies constraints of effective performance. For instance, at Kobo-Girana in Amahara region, old schemes constructed more than a decade are not fully operational, and even the new schemes are operating below capacity (Awlachew et al,2005). In the valley out of a developed command area of about 3400ha under about 13 schemes, only about 970ha of command area is operational (Awulachew et al, 2005). This shows less than one third of the schemes' capacity is effectively utilized.

Twelve of the 59 schemes in SNNP are not functional or fully functional (Awulachew et al, 2005). According to informants from the regional Bureau, the sites where the schemes have completely failed have created negative perceptions in the beneficiary communities. The causes of failure need further detailed investigations on an individual scheme basis (Awlachew et al,2005).

The situation in Oromia is not different. Studies indicate that efficiency in productivity and water use are respectively 50% and 40% respectively (OIDA, 2006). The efficiency of utilization of irrigation water is often low and around 50% of the increase in demand for water could be met by increasing the effectiveness of irrigation (Bello.W.B., 2008).

Kloos (1990) concluded that even though small scale irrigation has a long history in Ethiopia it remained relatively unimportant in food production in most areas. The emergency type of irrigation program implemented by the government during the 1984/85 famine appears to have increased food production in some localities but has been beset with numerous administrative, social, technical and ecological problems (Kloos, 1990).

Wagengew (2004) indicated that given the complex set of constraints facing smallholder producers, providing access to irrigation water by itself is not enough; smallholders also require a broad range of support services (access to inputs, credit, and output markets), knowledge of farming and secure land tenure. FAO (1997c) in Wagengew(2004) further identified the following constraints to be affecting the capacity of farmers to invest and manage irrigation projects:

- Poor resource base of farmers
- Fragmented and small size of land holdings
- Unsecured or lack of land titles
- High interest rates
- Poor transportation and marketing facilities

To improve the economic and environmental performance of small scale-irrigation schemes institutional support (input supply, output marketing and credit services), training of farmers on improved crop and water management issues, regular supervision and monitoring of scheme activities are crucial (Mengistu, 2008).

Pump capacity, maintenance cost, and lack of transparency (corruption), poor scheme coordination and management were identified as major problems in Dodicha (Mengistu, 2008).

According to Yohannes (2004) two sets of problem of Small-scale irrigation in drought-prone areas have been identified. The first category includes problem that are associated with the specific environmental characteristics of the agro-ecosystem. The second category includes common problems that drought-prone and degraded areas share with all other small-scale irrigation systems, irrespective of their agro-ecological context.

These are:

1. problems related to the physical nature of the irrigation systems, e.g. loss of water through seepage;
2. problems related to the application of irrigation water, e.g. upstream users abstracting too much water;
3. Problems related to marketing produce, e.g. transportation issues;
4. policy-related problems, e.g. security of land tenure;
5. engineering-related problems, e.g. lack of experience in planning and designing irrigation systems;
6. problems related to the irrigation economy, e.g. competition between rain-fed and irrigated agriculture; and
7. Community issues, e.g. levels of farmer participation.

2.6.1. The Non-Technical Dimension of Irrigation Practice

It was explained that the history of irrigation development has been characterized by emphasis on technical and engineering aspects, with inadequate attention to policy, institutional and socio-economic factors (Birehanu and Peden,2000). To improve the efficiency of water use in agriculture and to avoid further environmental setbacks, it is clear that human and institutional factors have to be taken much more into account in development programmes and investment strategies of donors and governments (Cogels, 2003).

The general lessons gathered from experiences with SSI in all regions in Ethiopia relate to the need to improve communication, community consultation and involvement in project planning and implementation, proper design with adequate timing and reference to local information and indigenous knowledge, technology choice and market related issues as well as adequate baseline studies prior to implementation (Awlachew et al,2005).

There is evidence that most modern irrigation development projects in Ethiopia including SSI,MI,RWH has already been a supply driven, technically focused approach, which has tended to ignore various factors that are relevant for making small holder irrigation farming sufficiently rewarding to justify investment costs and to achieve significant food security and poverty reduction impacts (Awlachew et al,2005).

Non-acceptance of irrigation schemes by farmers is the main social failure that results in cultivation of only a small part of the available potential area. This is largely the function of the top down implementation process often followed. It also suggests some of the interventions are often not appropriate, given the circumstances of the recipient populations (Awlachew et al,2005).

It was indicated that users of rainwater harvesting are benefitted in terms of improved horticultural production and income and factors such as literacy status of the head of household, household labor, household farm land size, credit availability, and distance to the nearby market and local institution are the major ones hindering the adoption and promotion of rain water harvesting (Zelalem, 2007).

Water users Association and Community Participation

The success of irrigation projects generally depend on the involvement of the concerned communities and a comprehensive analysis of the technical, economical, social and environmental factors (Debere, 2006). Organizational performance is an important factor in the sustainability and productivity of irrigation systems (Lemperiere and MartinL., 2006).

The highly centralized top-down approach to rural development in the past has had a negative effect on farmers working together as a group. There therefore needs to be a concerted effort to create awareness among farmers' groups as to the benefits of working together – such as better services relating to water distribution, increased bargaining power, access to credit, and improved infrastructure (Tafese, 2003). The keniyan experience demonstrates that farmers do much better when they build,own and operate the schemes themselves (Purcell).

Organization members must have the capacity and must adopt rules relating to : (Lemperiere and MartinL., 2006)

- Water distribution
- Mobilization of farmers for such labor demanding tasks as maintenance

- Financial management: collection of water fees, book keeping, payment to external service providers and employees
- Relations with administrative authorities ; adoption of legal status, information on legal regulations for farmer's organizations
- Internal communication ; mode of decision making ,conflict resolution, organization of meetings
- Establishment and development of relations with external organizations: service providers, traders, extension services, credit institutions projects, down stream and up stream users

Yohannis (2004) identified lack of community consultation and implementation during planning and designing as the main reason for the failurity of small scale irrigation schemes based on construction of micodams in Mekele Plateu of Tigray region.

There is ample evidence from all regions that most of the failed projects are those implemented with out sufficient and effective beneficiary consultation and participation (Awlachew et al,2005). Based on the experiences of four schemes in the Awash Basin in relation to project planning and community consultation Wagenyew(2004) explained it as follow.

> *... A major constraint in irrigation development is the top-down approach by the government and NGO's, which took farm population as beneficiaries rather than stakeholders. Technical experts and administrators make decisions on behalf of the farmer. Farmer's involvement in irrigation planning should be considered from the beginning. (P.101)*

Access to irrigation Land

The prevailing land tenure system is one of the critical elements that determine effectiveness of small scale irrigation practices. Access to land and water resources is crucial to utilize the resources. Various studies indicate the impact of irrigation land holdings on the efficiency of irrigation.

In SEAGA irrigation subsector guide line it was mentioned that with existing land ownership patterns the participants in the scheme are partly determined by land ownership and by the topography that determines the command area (Jordan, 1998). Landless and farmers who own land too far away or on high areas are thus excluded. Participants will thus most probably be land owners from various socioeconomic groups with land in the command area. However, there is some scope to involve those excluded through redistribution of land ownership or arrangement for leasing or share cropping of land.

An assessment by JICA/Nippon Koei (2003) in Central Oromia identified the following in one of the schemes and state that:

> *Quite considerable numbers of WUA members own large area of over 0.5ha with some extreme cases of 4ha resulting in farm labor shortage as a whole. Due to limited farm family labor against large labor requirement, substantial portion of the irrigable area is not fully utilized. Since the utility of WUA is adversely affected by such unfavorable land holding conditions, the members are too demoralized to maintain their scheme with mind of ownership. (p.5-6)*

The Ethiopian Water Management Policy and Irrigation Policies do not clearly address the issues of land tenure, as irrigation development requires huge investment on land (IDCOF, 2002). It was proclaimed that an individual is expected to own not more than 0.5ha plot in irrigation field in Oromia region (Oromia regional state, 1994). However implementing this policy in existing schemes and new proposed sites is still a challenge not only because of lack of organ responsible to implement this regulation but also absence of political commitment to enforce the rules and regulation. This is to be done through land exchange and transfers. Transfer is based on the right for land owner to inherit to his successor. While land reform legislation exists in many countries it is rarely implemented. The enforcement of land reform legislation essentially depends on political will (Emmanuel and Kaye, 1997).

The Institutional Aspect

There is no stable and uniform organizational and institutional set up across regions and over time that is responsible for irrigation activities in Ethiopia. The institutional set up and accountability issues vary from region to region and are not stable. As a result there is confusion on mandate, resulting in some cases of scheme failure due to lack of accountability (Awlachew and et al,2005). For instance, in Oromia region restructuring was made 8 times from the year 1994 through 2008 regarding establishment of organization responsible for irrigation development in the region. This could have its own negative impact for effective irrigation performance in the region. (For Further See Annex)

Marketing and other support systems

Adequate market information regarding input and output is crucial for irrigating farmers. Prices should be rewarding to boost the benefit from irrigation activity. Credit service is also important since farmers in most cases need initial capital.

Failure to develop markets specially for vegetable crops and identify high value crops may have reduced the benefit of irrigation (Mulat and Bekele, 2004).

Marketing of products, lack of extension services, lack of post-harvest facilities and lack of credit are major constraints in Dodicha and Haleku Small Scale irrigation Schemes both of which are pump schemes in Central Rift valley of Ethiopia (Mengistu, 2008).

Technology choice

Another important lesson related to successful irrigation performance is the technology choice. The choice of technology should consider the capacity of the beneficiaries to operate equipment on their own (eg. mechanized pumps) and to maintain the pumps and obtain spare parts (Awlachew et al,2005). The problems of incompatibility of small-scale irrigation technologies to a particular region's environmental and socioeconomic conditions can be minimized by identifying what are believed to be appropriate systems suitable for each region (Yohannis, 2004).

It is reported in Kenyan irrigation experience especially in relation to pump operation that:

...Marketing, distribution and servicing of equipment being poor. Pump breakdowns are a major problem; farmers are not trained to maintain pumps and do not generally carry spare parts (Purcell).

Pump projects are not very successful as farmers can not immediately handle the technology or afford the electricity for the pumps. Pump maintenance has also proved to be critical and poses major challenges to farmers, as spare parts are difficult to find. In appropriateness of technology is identified as one of the limiting factors for effective irrigation performance in Arsi Zone. Some schemes failed in this zone, particularly because farmers could not get spares for the imported pumps, could not carry out maintenance, and could not afford the electricity fees to run the pumps (Awlachew et al,2005).

Yusuf suggested that designing and constructing irrigation schemes has to consider the capacity and knowledge of farmers (Yusuf,2004). High electricity and repair and maintenance cost of pumps in Batu Degaga showed that electric powered pumps might be too costly for smallholder farmers (Wagegnew, 2004).

3. Description of the Study Area and Methodology

3.1. The study Area

The study area is located in Adama district of East Shoa zone,Oromia Regional State. Specifically it is located at about 132 Km from Addis Ababa and 32km East of Adama/Nazreth town. The project gets its name from the kebele and village named Batu Degaga that is located along graveled road from Sodare asphalted road to Upper Awash State Farms crossing Bofa and Doni towns.

The study area is specifically located at latitude of 09°31368North and longitude of 37°545083East with elevation 1346 masl using GPS.

The following figure shows map of the study area.

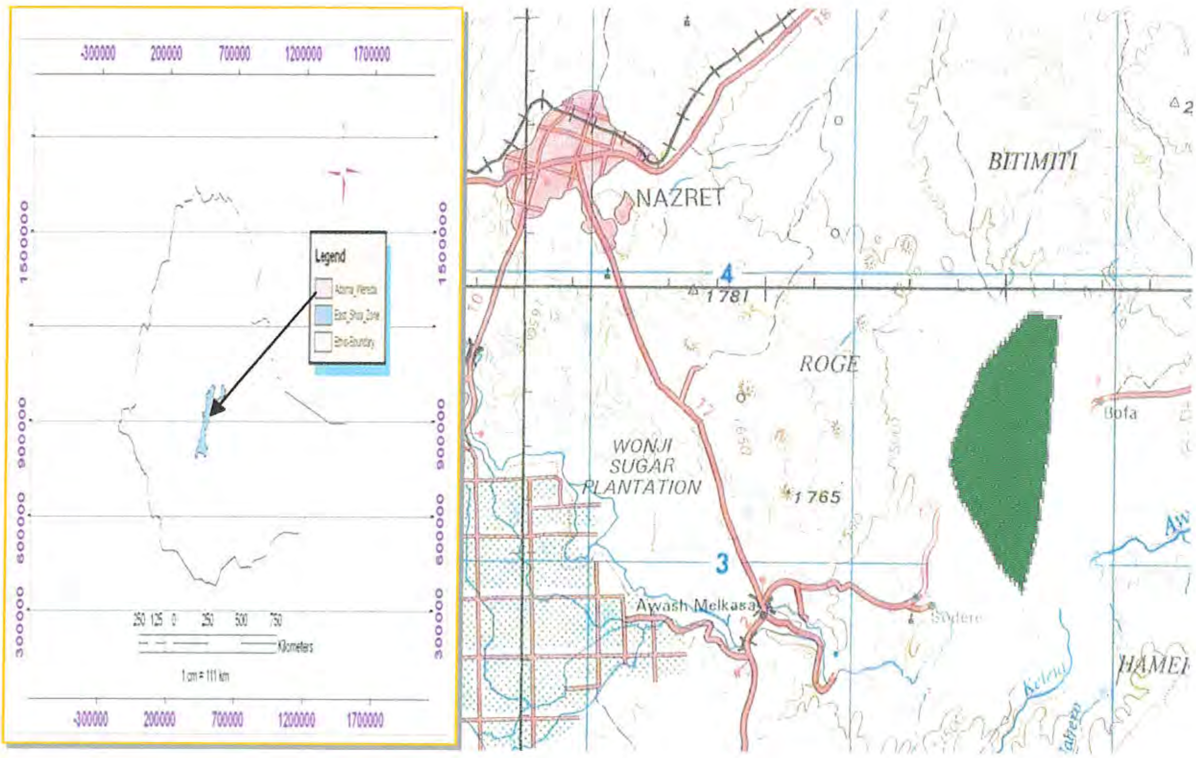


Figure 1: Map of the study area

The study area is found in the Awash basin. According to the Ethiopian Water Sector Development Program (2002-2016) the Awash Basin has total catchment area of 112700km^{2}with natural flow measured at Tendaho 4600m^3. The greater part of the basin lies geologically within the rift valley (MoWR, 2002).

The river emanates at an elevation of about 3000m in the central Ethiopian Highlands, west of Addis Ababa, west Shewa near Ginchi town and flows northeast wards along the Rift Valley into Afar where it terminates in Lake Abe at an elevation of 250 meters (Wagegnew, 2004). This river basin is the most intensively developed basin mainly not only because of good infrastructure, available land and water resources but also because it is not a trans-boundary river basin (MoWR, 2002). Despite its provision of hydropower at Koka , Awash II and III stations, large and medium sized irrigation projects owned by state enterprises are concentrated in this basin. The total potential irrigable area is estimated to be 151400ha and the total irrigated so far is 68800ha which is almost three quarter of the total land developed by the existing irrigation schemes of the country (MoWR, 2002).
Adama district is dissected by Awash River. Small Seasonal streams drain into it from high lying areas from the North and North east direction. There is no other perennial river in the district.

Recently there is expansion of small scale irrigation schemes that operate using diesel and electric power sources to some extent especially in Lume, Adama, Boset and Fentale districts. These pumps are either individually owned or communally operated the former having the lion share. In Adama district the total potential irrigable area is estimated to be 2489ha along Awash River. Of this 59.9% is made under irrigation. This does not include the one under Sugar cane plantation of Wenji-Shoa which is also currently under expansion.

3.1.1. Population

According to the May 2007 census of Ethiopia, the total population in Adama district excluding Adama town is about 155,321. Rural inhabitants account for 83.1% of the population. Female population represents 49.1% of the total population in the district.

Table 1: Population of Adama district

Area of Residence	*Population By Sex*			*% by residential area*		*% of total*		
	Male	Female	Both	Male	Female	Male	Female	Both
Rural	66255	62748	129003	51.4	48.6	42.7	40.4	83.1
Urban	12742	13576	26318	48.4	51.6	8.2	8.7	16.9
Both	78997	76324	155321	50.9	49.1	50.9	49.1	100

Source: Central Statistical Agency, 2008

The population density is about 470.2 persons per km^2 if Adama town is included. It is about193.5 persons/km^2 if the town is excluded.

According to Adama district agricultural and rural development office records the number of households who are land holders in rural Adama is about 25,342. Only 21.8% of the holders are women.

Batu Degaga is one of the Kebeles in Adama district with total population of 5547 comprising 44.5% male and 55.5% female. The total number of households in this Kebele is about 880 according to records obtained from the local development workers. About 140 households which is 15.9% of all households in this Kebele are direct beneficiaries of Batu Degaga irrigation scheme.

3.1. 2. Economic Activities

The livelihood of the people in the rural area depends on agricultural activities as elsewhere in the country. The farming system is characterized by both crop production and animal production. According to the Agricultural Sample Survey conducted in the year 2002, 28.9% of the farming households are engaged only in crop production, 10.8% of them are engaged in livestock production only and the remaining 60.2% practice both (CSA, 2002).

About 82.6% of the cultivated land is owned by small holders. The average arable land holding is about 1.23 ha.

Crop production

Nearly 39% of the land in the district is covered by annual crops. Main crops produced include teff, barely, wheat, maize, sorghum, horse beans, pea, lentil and haricoat beans according to the districts agricultural and rural development office. Teff among cereals is the main annual cultivated crop followed by maize and haricot bean in the district. The area growth under cultivation has increased at the rate of 1.5% on average while total output has increased at the rate of 13.8% in Adama district for the last eleven years. This suggests that much of the increase in output is not due to expansion in area but is due to various productivity enhancing factors.

Livestock Production

Livestock production is also one of the economic activities for oxen provide traction power and cows provide dairy products. There are about 31117 oxen in Adama district and the number of oxen per household is 1.2. This is not adequate as pair of oxen is required to till land. This indicates that there are households with out oxen and other arrangements are required for cultivation.

Small ruminants and chickens are not only source of additional cash income especially in case of crop failures but also means of accumulating wealth. Equines including camels serve as means of transport including transportation of agricultural products. The sector is constrained mainly by availability of limited grazing and drinking water for most of the kebeles.

Irrigation practice

In Adama district out of all cultivated land owned by small holders 4.8% is currently irrigated mainly by individual private pump owners. Out of 37 rural kebeles 13 of them are said to have potential for irrigation practice due to their proximity to Awash River. The only available irrigation technology was using lifting technologies. i.e. pumped irrigation. Major irrigated crops include tomato, onion, chilly, cabbage, maize and others.

Out of cultivated land in Batu Degaga , irrigated land is estimated to be 107 ha which is 10.4% of the cultivated land in the Kebele. About 60ha (56.1%) of the irrigated area belongs to the area under consideration. The rest 47ha which is 43.9% is developed by individual pump owners in different forms of arrangement. Limited number of farmers own private pump. In most cases pump owners secure plots from local farmers and the benefit for farmers is insignificant.

3.1.3. Climate

Climatically most part of the district experiences a kind of semi arid climate. The nearest weather station to the project area is that of Awash Melkasa Agricultural Research Centre. This station is located at an altitude of 1550masl. Maximum rain fall occurred in the months of July followed by August taking the average of the last eleven years. The distribution of the rainfall pattern is depicted in the following graphs.

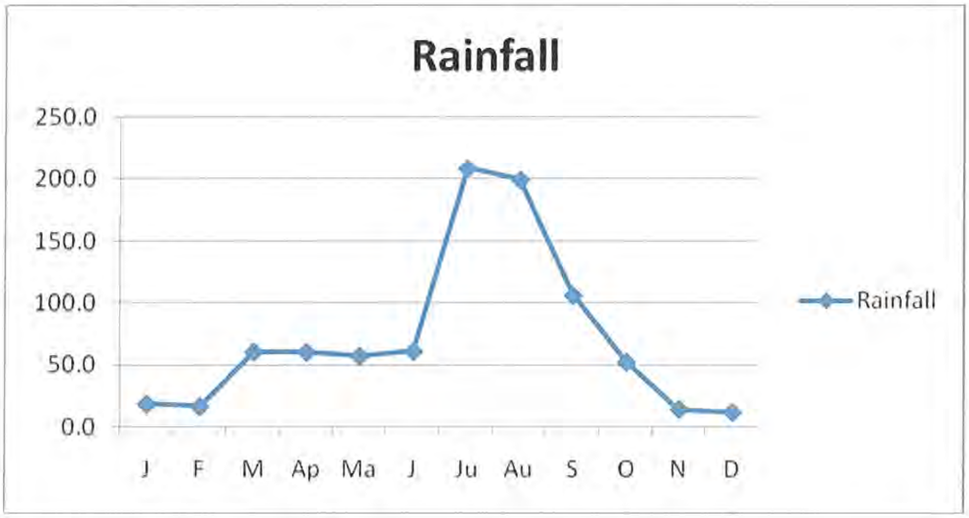


Figure 2: Line graph showing monthly rainfall distribution at MARC(1998-2008)

It was also tried to see annual variation for the last eleven years as shown in the following graph.

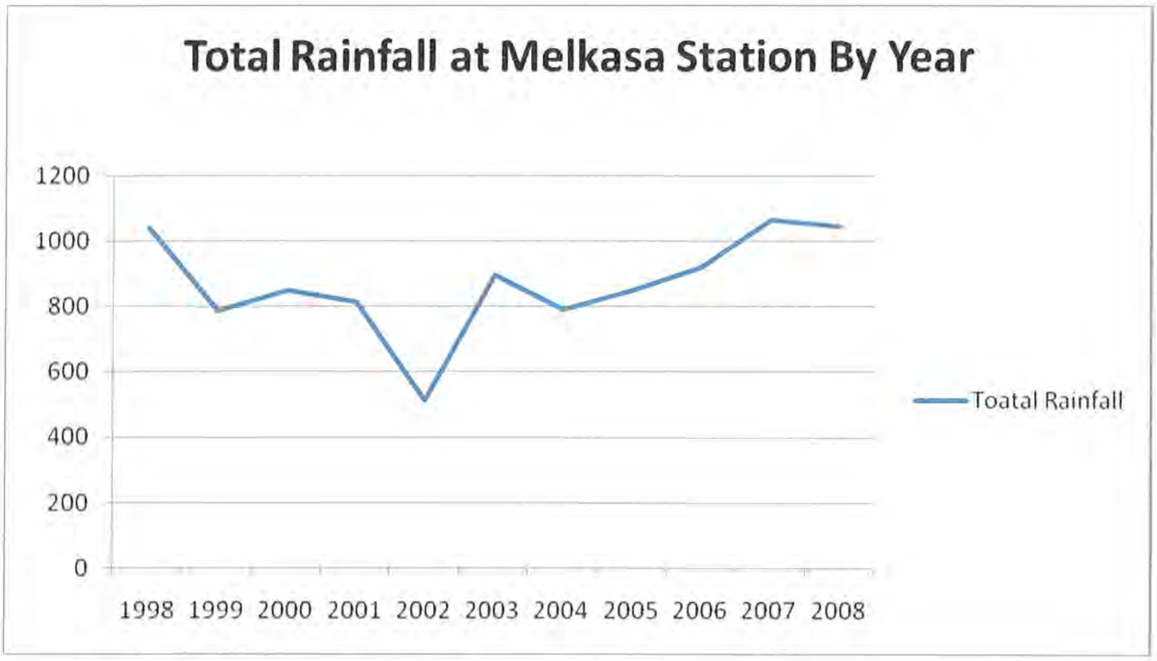


Figure 3*: Annual Rainfall pattern of the last 11 years at AMARC*

From figures 3 and 4 it can be seen that there is monthly as well as annual variability in rainfall pattern which can significantly affect agricultural production. The average rainfall amount is about 869.8mm with sd of 156.7mm. The minimum and maximum annual rain fall based on average of last 11 years are 512.6mm and 1064.7mm respectively. According to key informants variability of rainfall become a challenge for growing crops. Livestock feed availability is also constrained.

Monthly maximum tempratuire is recorded in the month of May which is 31.8°C and the minimum monthly average is recorded to be 10° C which occurred during the month of December based on average of the last six year Melkasa weather station.

From the climatic information it can be infered that the area can be categorized as semi arid type of climate in which irrigated agriculture become a necessity to sustain livelihoods.

3.1.4. Topography, land use and soils

The topography is undulating ranging from flat to rugged mountains. The highest peak in the district has elevation of 2430 masl and the lowest is probably the study area since it is almost on the border line with other district namely Boset along Awash River. North and North West of the project area is severely dissected and is made up of tertiary basalts. (AEC ,1990)

The total land mass of the district is about 80260 hectares. About 47.2% is cultivated area which includes land under Wenji shoa sugar plantation and the one owned by Melkasa Agricultural Research centre.

According to sources from records of development workers the land use pattern of Batu Degega kebele in which the project found is summarized in table 2.

Table 2: Land use Pattern of Batu Degaga

No	Type of use	Area in Ha	%
1	Cultivated land	1030.5	48.5
2	Vegetation	600	28.3
3	Rugged and mountain	206.5	9.7
4	Residence and others	286.36	13.5
	All	**2123.36**	**100**

Source: Area Development worker and Data manipulation

As depicted in the table 2 about 48.5% of the land of the kebele is cultivated. Close to twenty eight percent is covered with vegetation. Most of the natural vegetation that comprises indigenous species is found along Awash River. Otherwise one can observe scattered acacia trees and other thorny bushes that are under destruction mainly for sale and household level energy consumption.

Light in color, medium textured and amorphous structure are the main features of soils of the catchment (OIDA Central Branch, 2007).The soil of the project area is generally light and well drained and agronomicaly it is possible to produce a wide range of horticultural crops (AEC, 1990). On the other hand the sandy nature of the soil texture caused high rate of infiltration and low water holding capacity that resulted in lose of water and affected especially distant plots according to focus group participants.

3.1.5. Vegetation

It was estimated that 6.5% of Adama district is forest land. Natural vegetation covers only 1.2%. This is mainly found along Awash river bank and enclosed areas. In Batu Degaga Kebele the proportion of vegetation cover is 28.3%. Hill sides and steep terrains are covered with bush and shrubs.

3.2. Research Design and Data Collection

The selection of the study area Adama district and the project it self is based on the relative importance of irrigation practice in the district and accessibility of the site. Moreover the project is known by the researcher for a long time which initiates him to study the problems and challenges faced by the irrigators. Primary and secondary data were collected by employing quantitative and qualitative methods. The population for the study was the users of Batu Degaga irrigation project. The data collection was under taken from January to February 2009 followed by data organization, processing, analysis and report writing. Data from different sources is triangulated to get reliable information.

3.2.1. Household Survey

The study employed survey research strategy that involves collection of information in standardized form from groups of people the purpose being exploring and explaining factors of effectiveness. Two types of questionnaires were designed, one with limited number of questions as a check list that focuses on household basic data to be filled for all households the main purpose is to use it as a sampling frame since there is no systematic record keeping by WUA leaders and fluctuation of members. The other type of questionnaire with detail investigation is to be filled by selected households. Closed and open ended questions have been included in the questionnaires. About 50 households from a total of 140 are selected for interview using structured questionnaires. The number of female headed irrigators is 29. About 22% of the respondents are female household heads. The population is supposed to be heterogeneous with respect to gender and hence it was found necessary to have strata of male irrigators and female irrigators. Other wise it is assumed that the beneficiaries are assumed to be homogenous within each strata and simple random sampling was applied to select respondents from each strata. Random number generator of the computer program was used to select the sample. The questionnaires were filled by trained enumerators with close monitoring and follow up of the researcher. Before the actual survey, pretesting of the questionnaires was undertaken. Based on the feed back of pretesting, some modification was made on the questionnaire.

3.2.2. Observational method

Total area proposed, actually irrigated field, irrigation facilities used and different activities of the Participants such as field preparation, irrigation practices and types of crops grown by the participants were observed at the field level and main relevant issues were discussed with the participants. Photographs are also taken as aiding tools. Grid coordinates were collected using GPS for the purpose of preparing map of the study area.

3.2.3. Focus Group Discussion

Discussion was held with users of the scheme. About six participants in which one is a woman are participated in the discussion. Open ended questionnaires were used for discussion. The main points of discussion include challenges and constraints related to irrigation practice, availability of water at the time of need, how they manage their plot in the target area, how benefit from irrigation practice can be explained, types of crops they grow often, problems related to pump scheme and managing common property, marketing issues and if there is a season in which production is ceased and the reason.

3.2.4. Key informant Interview

Development workers, WUA leaders, teachers, agricultural development staffs and others were interviewed using unstructured questionnaires. The contents the interview include planning and designing issues, level of community participation, main constraints of the irrigation project, targets and achievements, operation expenses and challenges , water distribution and power issues, fee collection, project impacts, replacing the equipments and others.

3.2.5. Secondary Data

Secondary data were collected from statistical publications, research publications and other published and unpublished sources which are used to substantiate and enrich information collected using other research instruments.

3.3. Data processing and Analysis

The survey data and other quantitative data generated from secondary sources were analyzed using quantitative methods that involve descriptive statistics and logistic regression analysis. SPSS soft ware was used in processing the data. The qualitative data generated through focus group discussion, key informant interview and observations were explained in words and depicted figuratively.

3.3.1. Binary Logistic Model

Binary logistic model is introduced to study the impact of irrigation on the quality of life of the participating households as a proxy to study effectiveness of small scale irrigation. Too often it was said that due to irrigation practice livelihoods improve but not all participants benefit equally. In other words there is differentiation in earnings due to irrigation projects. What factors characterize those households which gain more from irrigation practice? To characterize those households who improve due to irrigation practice and not improved in their living standard binary model is found appropriate.

This model is similar to linear regression model but is suited to situations where the dependent variable is dichotomous. i.e it takes only two values, which usually represent occurrence or non occurrence some out come or event usually coded as 1 0r 0 and the independent (input) variables are continuous, categorical or both.

Logistic regression is popular in part because it enables to overcome many of the restrictive assumptions of Ordinary Least Square(OLS) regression such as homoscedacity (constant variance),linearity and normality.

Logistic regression coefficients can be used to estimate odds ratios for each of the independent variables in the model. It calculates the changes in the log odds of the dependent not changes in the dependent it self as OLS.

The functional form of the model is specified as following Aldric and Nelson (1984) in Million(2003)

Pi=pr(yi=1)=exp(Zi)/1+exp(Zi), where Pi denotes the probability that the i^{th} farmer will fall in the group of farmers whose living standard improved (yi=1) and exp(Zi) stands for the irrational number "e" to the power of Zi. The stimulus index (Zi),is called the log of the odds ratio, in favour of improvement of living standard, which is a linear function of factors affecting improvement from irrigation at household level.

$Zi=\ln[pi/1-p]=\beta o+\beta_1X_1+\beta_1X_2+\ldots\beta_pX_p+e_i$ where,

$\ln[pi/1-p]$ =log of odds ratio

βo= constant term which is also the intercept

β_is are the regression coefficients and X_is are the independent variables and e_i is the error term.

$OR=e^{\beta}\rightarrow \ln^{OR}=\ln e^{\beta}\rightarrow\beta=\ln^{OR}$,OR stands for Odds Ratio

The dependent variable (log-odd ratio) is the natural logarithm of the ratio of the probability that the i^{th} farmers living standard was improved after participating in the project(p) to the probability that the i^{th} farmers living does not improved (1-p). In other words p measures the probability of success from irrigation and (1-p) some times denoted as q in bionomial distrubution measures the probability of failure.

Several studies employed logistic regression to study impact of development interventions, adoption of improved practices and impact of technology on the livelihoods of the participants. The following are few of these empirical studies.

For instance Bezabih et al (2002) used logistic regression to study the impact of microfinance institutions on the participating households. In the model improvement in income level was used to categorize clientele in to those with improved income and those without improvement.

Abebe (2004) estimated a logistic regression to identify factors characterizing household's perception of their status of livelihood comparing situation in 2002 with that in1996. A number of explanatory variables including livestock ownership, age, sex and education of the household head, amount of chemical fertilizer procured and other are used in the model. According to the findings of this empirical study amount of fertilizer procured and number of children in a family are identified to be few of the variables determining the probability of a household head's perception whether livelihood has relatively improved or not.

Werkineh and Roth (2002) applied logistic model to examine factors of input oriented commercial participation and use of chemical fertilizer and found out that adoption of chemical fertilizer and improved seed varieties being influenced by size of farm holding, credit access, educational level of household members and agro ecology using the model.

Mulat and Bekele (2004) applied logistic regression to study the impact of demographic variables, various socioeconomic attributes and natural factors on sustainable intensification.

Moreover binomial logit model was employed to identify demographic, social, economic, physical, institutional and technical factors which influence farmers adoption decisions of improved 'Enset' processing devices (Million, 2003).

According to this findings farm size and access to extension agents positively and significantly influenced adoption of improved 'enset' processing devices in the study area.

4. Data Analysis and Results

4.1. Batu Degaga irrigation project

The project under study is one of the communally operated schemes. There are only two communally operated modern schemes in the district both of which are implemented by World Vision Ethiopia. The total area irrigated by these schemes is about 100ha.

The project is implemented by World Vision in the 1990s. The system of extraction is pumping from Awash River. Three sets of pumps each with 30kwh are installed. About 140ha of land is planned to be irrigated. Currently about 42.9% of targeted area is developed.

According to the design document prepared in the year 1990 by Associated Engineering Consulting firm the project area does not get adequate rainfall which is less than 760mm per annum to support sustained agricultural development under rain fed conditions (AEC,1990). Harvest did not exceed 6qt/ha before irrigation.Famine,disease and mal nutrition were common (AEC,1990). Irrigation was identified to be the only option to secure household food supply and to generate additional income according to the design document. It was also emphasized that the only source of water that can be used for development were Awash River by pumping. It was proposed to install two 50Kw electric motors. The source of energy is from existing power line that passes through the project area for Degaga State owned farm which is adjacent to the project. The total operating expense to run the pump was estimated to be Birr 6600 per year. The net irrigable area is about 140ha hactares for 280 targeted households. The majority of the settlers are displaced people due to expansion of Wenji sugar cane plantation.

Two season cropping is recommended. The average value of gross production is estimated to be Birr 1,043,522. The gross value per household (280 beneficiaries) is accordingly Birr 3727 per year. Expenses including farm inputs and pump operation expenses are estimated to be Birr 764 per household (AEC,1990). This indicates that the net benefit from irrigation per participating household is about Birr 2963 per year.

Major irrigation facilities include Pump house made of Corrugated Iron Sheet roofed and wall, concrete floor, suction pipe, delivery pipe and pool, main canal of Concrete pipe, division boxes, access road and other farm structures. Three pumps are installed in which one serves as reserve currently one of these pumps is damaged. And the remaining two pumps operate in turn.

Figure 4: Suction pipes and the Awash River which is the source of water for the project

Figure 5: Delivery pool, only one of the pumps is operating

Figure 6: Main canal and Division boxes

Office is also constructed for the scheme management together with other irrigation facilities. Currently the rooms serve as living room for development workers and teachers. The WUA is using only one of the rooms out of a total of 4. Additional room may be required to store spare parts and documents but they use the same room. The WUA has the right to use other rooms if there is a need. Otherwise there is no as such strong organizational hierarchy requiring additional offices and office supplies. Hence lack of office is not a significant problem for the operation of the scheme. The development worker is also one of the agents for agricultural development in the area including irrigation.

4.1.1.Construction costs and community participation

Construction of the project was undertaken from the year 1991 through 1992. The total cost per hectare is estimated to be Birr 4780. Total construction cost is summerized as follow.

Table 2: Cost Components of Batu Degaga irrigation scheme

Cost by type	*Amount in EBR*	*%*	*Remarks*
Cash	483830	69.2	
FFW Commodity	207140	29.6	Wheat and oil
Community Contribution	8220	1.2	Free Labor
Total	**699190**	**100**	

Source: World Vision Ethiopia Adama ADP

The contribution of the community is low compared to what is expected by donors. Most donor organizations require a minimum of 10% contribution from beneficiaries of small scale irrigation schemes be in terms of free labor, cash or supply of local materials. Some key informants suggest dependency sentiment being developed among users because of low community cost sharing and hence contributed towards lack of effectiveness of the scheme.

4.1.2. Scheme Management

There has been fluctuation of members since the establishment of the WUA. Currently there are 140 users of the scheme. The WUA is leaded by committee members elected by general assembly. The chair person, secretary, audit and inspection, accounting clerk are among the duties of WUA leaders. There are two employed individuals who serve as guard and operator. There are eight blocks for water distribution purpose and block leaders who control the distribution and scheduling. Violating water scheduling is mentioned to be the main conflict in which the destitute such as women and old people are affected specially in the past. The violators can be punished about birr 100 if found guilty based on the internal bylaw of WUA.

4.2. Settlement Patterns

The users of the scheme live in a village locally referred to as 'Awragodana' which is established near camp of road constructing agency some years ago. There are a few corrugated iron sheet roofed houses. Grass roofed house made of hallow block of mud dominate. The former is increasing according to key informant because of increased income from irrigation.

Figure 7: Residence of the community partially

The project is not close to the settlement area of the people which has the following outcomes.

- Limited use of irrigation water for other purpose like domestic use, livestock drink, washing and bathing because of same proximity to the main water source
- Water borne and water related diseases including malaria are reduced if not totally avoided hence the health impact of this project is found insignificant from Key informant and focus group discussion
- There is cost of crop protection from wild life and thief
- There is economical use of water due to associated high running cost in relative terms which reduced mismanagement of water. Due to this fact and sandy nature of the soil, salinity problem is not critical.

4.3. Plan Deficiencies that limited effective performance

All land targeted is not developed by the system and the number of proposed beneficiaries was reduced by half. Main reasons according to key informants:

- The pump capacity is low (the installed pumps are not as per design) and hence no enough water to irrigate all plots at the same time. Two 49Hp pumps are proposed but 3 low horsepower pumps are actually there at the site.

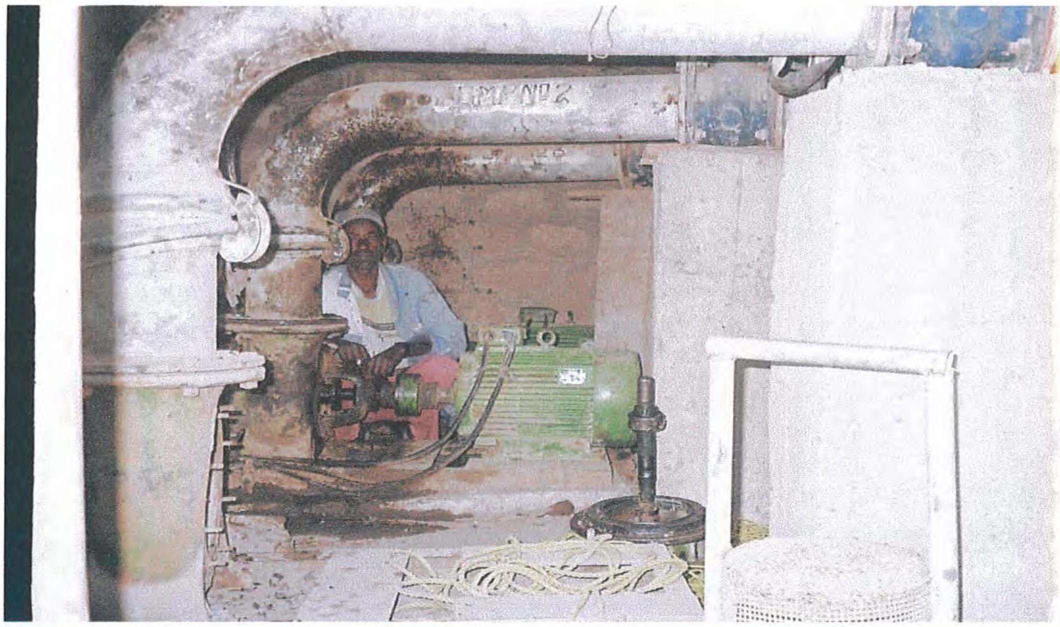


Figure 8: The pumps and the pump operator

Figure 9: Irrigation structure on the other side of the road but water could not reach

- There are problems related to the topography where water can not reach some plots in the command area. This means there is problem with land leveling or the plan did not take into account the existing land feature at the design phase.

Figure 10: Plot uncultivated due to the topography

- There are people who own large plots even though there is an agreement to manage a maximum of half hactare of plot. Implementing irrigation land policy was a challenge.

According to key informants currently there is progress and much land is cultivated compared to years before. This is mainly attained by implementing the existing rules and regulations including internal bylaws according to the views of the WUA leaders. Currently about 600 birr per 0.5 plot of land per season is collected for pump operation expenses. The amount was Birr 200 before three years. The payment rate is high compared to the past may be because of high price of agricultural products in which the farmers can afford to settle the bill.

- Some users of scheme do not cultivate their plots due to various reasons. It was found that resource poor farmers Cultivate low value crops such as maize or leave uncultivated. Wealthier farmers cultivate high value crops such as onion and tomato and benefit accordingly.

Figure 11: Maize mostly irrigated crop by resource poor farmers

- Some farmers rent out or share crop their plots to others.

Figure 12: Leased plots with onion

4.4. Impact of the project on Food security, Income and Employment

4.4.1. Food Security and Nutrition

The definition for household food security has four major components. These are availability, access, utilization and asset creation.

Availability as component of food security refers to household's capacity to produce the food it needs where as access is the ability of the household or individual to purchase food (Young, 1997). As asset creation is concerned the household's sale their assets such as livestock which they own in years of prosperity to purchase food items during grain short falls (Mesay, 2001).

Assessment of food insecurity is a difficult issue as there are no universally established indicators which serve as measuring tools as described by Debebe(1995) in Mesay(2001).However it was explained in the same source that several researchers agree that numerous inter related socioeconomic, environmental and political factors determine the food security situation of a society. These factors include the ability of the households to produce or purchase adequate food, size of land holdings, off farm income opportunity, availability of sufficient number of livestock particularly oxen, and households access to several valuable assets.

Several food insecurity indicators have come into use with the development of the concept of food security however the utilization depends on the procedure, purpose and depth of the research. Three major important indicators have been developed which enable to assess, analyze and monitor food security situation. These are supply, food access and out come indicators.

Supply indicators are not appropriate to analyze food security situation at household level but seems to be appropriate at national and regional levels. On the other hand access and outcome indicators serve better to measure household food situation (Mesay,2001).

Because of the irrigation project land use practices have been changed because of two season production and types of crops cultivated and hence there has been dietary change. The irrigators start to consume vegetables after irrigation compared to before the project. On the other hand income has been diversified because of the irrigation project.

Table 3: Estimation of Net income per household based on average irrigable land (0.48ha)

Item	units	Quantity/0.48ha	Unit cost(Birr)	Total (Birr)	Remarks
Gross income				**16426.30**	
Production expenses				**5199.07**	
Labor	Md	81.16	20	1623.22	
Oxen	Oxen days	8.9	20	178	
Fertilizer	Quintal	2.36	400	944	50% of fertilizer
Chemical	Liters	3.17	320	1014.40	Average of varies chemicals
Farm tools(depreciation)				154	
Seed/seedling cost				85.45	
Pump operation expenses				1200	
Net Return Before Tax				**11227.23**	

Source: Survey data manipulation

Food consumption frequency has also increased according to key informant and focus group discussion from a minimum of once a day to a minimum of twice a day.

Recently percent of household's emergency needs developed by FANTA is used as indicator of food insecurity condition. In the survey the respondents were asked whether any of the household members received food aid or not in the last twelve months and the response of all is they never received. The perception of the households regarding food insecurity is imbedded in their perception of change in living standard after the project and the response of 62% were positive. This means the respondent's perceived improvement after irrigation and hence their food security situation is expected to get improved.

Table 4: Estimation of household Food grain Availability

No	variable	unit	Quantity
1	Average Land Holding	Hectares	1.7
2	Out put before project	Quintals	10.2
3	Output After Project	Quintals	20
	Family size		5.3
	Per capita food Production	Before Project	1900kg
		After project	3774kg
	Net income from irrigation/hh(Birr)		11227.23

Source: Own data Manipulation

As it can be seen in table 10 based on World standard of 2100kg/head per annum grain production was not sufficient before the project and there is high level of food insecurity problem. Currently grain available per head is about 3774kg/head /year on average. This may be as a result of supplementary irrigation. Due to increased money income their purchasing power is improved and hence access to basic needs including food is created due to the project. However this is based on average value and the impact of the project on each individual varies. From the definition of food security which is 'access to enough food by every individual every time' we can not infer that every member in the project area is food secured but there is an improvement due to the project.

More over the available food includes not only grain but vegetables from irrigated field and that consumed at home. Due to increased income there is investment in purchase of livestock such as cows and hen and hence dairy products and chicken products can be consumed at home. This indicates improved nutritional status of the households after the project compared to before the project.

For regional and global assessments, per capita food intake per day in kilocalories is used as the indicator for food security. This indicator is derived from agricultural production and trade statistics. At the national level, a per capita food intake of less than 2200Kcal/day is taken as indicative of a very poor level of food security, with a large proportion of population affected by malnutrition (FAO, 2003).

A level of more than 2700Kcal/day indicates that only a small proportion of people will be affected by undernourishment (FAO, 2003). It must be stressed that per capita food intake in terms of kilocalories is only an indicator of food security: adequate nutrition requires, in addition to calories, a balanced diversity of food (FAO).

4.4.2. Migration and Employment

Irrigation practice has been expanding in the area. Irrigation is labor intensive which can absorb underemployed labor at rural areas. Family labor is mainly used by poor resource households. In some cases social arrangements such as 'debo'[a] are used. Limited households hire additional labor. Well to do urban people lease farmers plots and irrigate using individual pumps. As a result there is inward migration in need of casual labor. These all facts are indications of the impact of irrigation being considerable in absorbing rural disguised unemployed labor and also minimizing rural-urban migration. Asked for availability of off farm employment opportunities the respondents indicated working on individual irrigator's field was mentioned as one of the options.

Figure 13: Irrigation is labor intensive, onion harvesting at Batu Degega

[a] Debo is social work in rural areas where people are asked to support each other for some labor intensive activities in which the host provides lunch or dinner but no payment in cash.

4.5. Results of Descriptive Statistics

4.5.1. Households and Their Characteristics

About 98% of the respondents belong to Oromo nation and 90% are followers of Ethiopian Orthodox faith. Twenty point seven percent (20.7%) of the families are headed by women.

The average age of the household head is estimated to be 40.7 years with sd of 12.9. The maximum age of the household head is estimated to be 65 years. Only 4% of the respondents are aged 60 and above. The minimum age is 18 years. About 24% of the household heads are under the age of 30. These mainly acquire plots for irrigation through land transfer. That is inheriting from their families. The average family size is determined to be 5.3 with sd of 2.75. Active labor force taking the ages from 10-65 based on CSA is 3.48 per each family with the corresponding sd of 1.9. The most probable active labor force in a family is four which has a frequency of 30%.

About 32% of the respondents do not own oxen at all. The following table shows the cumulative frequencies of oxen ownership.

Table 5: Status of Oxen ownership by the respondents

Number of oxen owned	*Cumulative frequency (%)*
0	32
≤1	58
≤2	90
>2	10

Source: own survey data

This indicates most households lack oxen which is the main source of traction power.

Number of livestock owned in TLU is on average about 2.97 with sd of 4.92. The coefficient of variation is 165.6%. The most probable value of livestock holding is 0 with 8% occurrence. It was identified that livestock possession is one of the means by which households save their income as there is no any bank system in the area. The livestock are also sold at the time of crop failures and other insecurity conditions.

Average land holding is about 1.7ha with sd of 1.2. Average irrigation land holding is estimated to be about 0.48ha. About 14% of the respondents own individual diesel operating pumps.

4.5.2. Main Rain Fed Crops and Irrigated Crops

About 30% of the consulted households cultivate maize, teff and haricot beans and the rest cultivate one or two of these crops using rain. Except sweet potato all crops proposed for irrigation namely tomato, onion, chilly and maize are irrigated.

Figure 14: Main irrigated crops

Onion, tomato and chilly are identified to be high value crops which are mainly produced for sale while maize is considered as low value and produced for home consumption. About 46% of the respondents cultivate combination of high and low value crops at different seasons. About 42% of the respondents manage high value crops in most cases and 32% of the respondents own other plot for irrigation outside the target area which is self managed or in different forms of lease arrangement. The following table summarizes proportion of area and farmers by crop type.

Table 6: Distribution of types of crops cultivated

Major rain fed Crops			*Irrigated crops*		
Crop type	*% farmers cultivating*	*% area Cultivated*	*Crop type*	*% farmers cultivating*	*% area Cultivated*
Maize	68	34.5	Onion	86	46.6
Teff	72	42.7	Tomato	20	13.5
Feba bean	2	0.8	Maize	58	34.2
Haricoat bean	40	22	Chilly	14	5.7

Source: Own data

From the table teff accounts the lion share in both proportion of cultivators and land allocated during main rain season while onion is the most irrigated crop indicated by proportion of farmers and size of plot.

About 40% of the respondents do not produce sufficient out put using rain fed and the major coping strategies mentioned are irrigation practice and other off farm activities, 96% of the respondents produce for both sale and household consumption using irrigation and only 4% of the respondents produce for sale.

Petty trade including sale of local beverages by women are identified to be off farm activities induced by expansion of irrigation practice in the study area. Some socioeconomic groups are employed on individual (private pump owners) irrigation farm as wage laborers and earn income.

The better access to irrigation water enables the rural poor to diversify their income sources including non-farming livelihood activities and to make savings having a considerable potential to decrease livelihoods vulnerability and reduce poverty (Nargita).

4.5.3. Input Utilization and Constraints of Crop Production

Asked to rank three major problems that affected crop production 16% ranked lack of inputs such as fertilizer and improved seed materials. On average about 4.7 quintal of fertilizer is procured annually. All respondents use fertilizer for both irrigated and rain fed crops. Asked for the main constraint of fertilizer use for irrigated crops 54% mentioned lack of cash at hand while

46% of them mentioned in accessibility during dry season since fertilizer is distributed by government only during main cropping season which is identified as 'Meker'.

About 3.2litres of agrochemicals is procured on average. The main chemicals include insecticide and herbicides. Irrigated crops demand more application of agrochemicals compared to rain fed crops. The difficulty to procure agrochemicals in protecting crops together with shortage of money to pay pump operation expenses oblige resource poor households either to grow low value crops such as maize or lease out their plots to others based on information generated from focus group discussion.

Figure 15: The cost of crop protection from pests and fungus is considerable, chemical spraying at onion field

The proximity of Melkasa Agricultural Research Centre was found noteworthy in accessing improved varieties of both irrigated and rain fed crops. About 48% of the respondents own three types of farm tools for irrigation practice. In most cases they include hoe and shovel.

4.5.4. Participation during Planning of Project

Recently it was confirmed that lack of stakeholders in general and beneficiaries to be factors for the success or otherwise of development endeavors. Community consultation is considerable in designing an irrigation project. However too many researchers concluded the history of irrigation development as supply driven and technically focused (Awulachew et al 2005; Biranu and Peden,2000; Lema,2004).

Based on the key informant discussion made the implementing agency is involved in the area as humanitarian action but gradually transformed it self to development Partner. The project was initiated in the early 1990s. All people in the kebele participated as Food for work program. The area was initially fallow serving as communal grazing land. There is also suspect from the community in that the land may be not for community use but for expansion of near by state owned farm. There is dependency sentiment due to the past development approach in which they need external support according to key informants and other supporting documents.

Based on the survey data 32% of the respondents contributed free labor and the rest contributed free labor, cash and supply locally available materials.

4.5.5. Plot Acquisition and Management

It was also tried to assess the nature of respondents in relation to plots in the target area and how they become members of WUA.

Table 7: WUA members Plot ownership

No	*Type of arrangement*	*%*
1	Own plot	66
2	Land Transfer	26
3	Land exchange	6
4	Renting in of plot	2
Total		**100**

Source: own data manipulation

From the above table it can be seen that the possibility to get plots in command area is limited as only 6% acquire plots by exchanging. This can be considered as one of the factors for lack of effectiveness of irrigation schemes as one can see plots which are not cultivated through out the year because of lack of resources to cultivate huge plots. Farmers do not want to lose their plots in one way or another.

Figure 16: Some people own large plot and cultivate part of it and leave the rest

Transfer or inheritance to family members seems easier to implement irrigation land policy that asserts a household to have a plot of not more than 0.5ha in command area of irrigation in Oromia Region. In most cases there is no real resource transfer in this kind of arrangement. This resulted in low performance of schemes and associated matters such as fee collection and participation during maintenance activities such as canal clearing. The problem is critical in schemes that require additional running expenses such as paying power fees. Asked for whether the respondent cultivates his plot in the target area or lease it out in any kind of arrangement 28% said yes and the reasons why they do so are mainly lack of cash to purchase inputs including paying for pump operation expenses and lack of oxen.

Wagenyew found out that in Batu Degaga about 55% and 14% of the farmers give their land for share cropping and rented it out respectively (Wagegnew, 2004).

4.5.6. Replacing Capital Equipment

The project life span is on termination however there is no mechanism designed to make the system sustainable. It was tried to assess the willingness as well as reasons not to deposit money for depreciation. All of the respondents are willing to replace however for the question who should replace only 78% said the beneficiaries and the other 20% said the government.

About 82% of the respondents mentioned absence of agreement during the initial phase of the project to be the main reason for not depositing money for replacing the capital equipment and the rest attached weakness of WUA management.

According to key informant electric power was preferred over diesel because of its cost and accessibility. Currently one of the pumps is damaged and out of use. Two diesel pumps which can irrigate about 8ha are purchased in the name of the WUA. However how to use these pumps is not clear. In the future there is a plan to purchase a pump to replace the existing old pumps. This is by collecting birr 1000 from each member according to leaders of the WUA.

4.5.7. Perception on Different Services Provided by Government and other Agencies

The following table summarizes response of the respondent's regarding availability and adequacy of the services. The figures are proportion of the respondents in percentage.

Table 8: Distribution of the perception of Services by respondents

No	*Services*	*Ratings and % of respondents*				*Total*
		Very good	Good	Not good	Bad	
1	Marketing information	30	16	52	2	100
2	Provision of credit service	4	32	64	0	100
3	Input supply and availability	54	38	4	4	100
4	Advice on irrigation water mgt	62	28	8	2	100
5	Training on pump operation and spare parts	22	50	28	0	100
	Overall Performance	**34.4**	**32.8**	**31.2**	**1.6**	**100**

Source: Survey data manipulation

From the key informant interview in relation to the availability and adequacy of support system the participants mentioned that Development worker for the project was assigned few years ago but not now. This is associated with restructuring of organ responsible for irrigation development. Since 1994 institution responsible for irrigation development in Oromia region has been restructured about 8 times indicating lack of stability. Currently they are supported by generalist development worker not only for irrigation. Wereda experts visit the area sometimes. The credit service is not adequate. The proximity of Melkasa Agricultural Research centre is found beneficial in that there are on farm level experimentations on the farmer's field which are good for learning process. The focus of current research is to identify fertilizer rate to be applied on onion field which is the main irrigated crop in the area mainly by market oriented farmers.

Figure 17: On farm trial by AMARC to study optimum fertilizer rate for onion

4.5.8. Factors Affecting Performance of the Scheme

Respondents are asked to rank and provide three important factors that determine effectiveness of irrigation practice. Accordingly 30% of the respondents ranked respectively technological incompatibility such as managing pump, input and output markets and organizational problems in using common properties as first, second and third priority problems that determine performance of irrigation practice. Where as the later (use of common property) is identified to be the most frequent problem mentioned by the respondents.

Problems related to fee collection and lack of organized book keeping systems is mentioned to be among the problems from key informant interview.

The main factors which caused variation in benefit earned from irrigation are indicated to be the following from focus group discussion.

- Plot location: the lesser the distance the water travels from the source the more the impact of irrigation. This can be explained in terms of distant plots do not get adequate water.

Figure 18: Distant plots left uncultivated because of water shortage

- Initial capital: cash is needed to start irrigation especially to manage high value crops such as onion and tomato and benefit accordingly. This can be secured by getting more benefit from rain fed crops, sale of livestock or credit availability. In general it depends on the wealth status of households.

The variation between individual pump owners which is mainly owned by people coming from towns including Adama and the project under study was also discussed. It was observed that the pump owners plot is managed well and the main crop is onion while maize dominates at the project under study. Variation in soil, access to water and working capital are mentioned to be the major accountable factors for the disparity according to the views of participants of focus group discussion.

An 83 year old man mentioned the main factor for low benefit from irrigation is due to getting inadequate water, lack of cash to cover expenses related to pump operation. He told me that currently he owned no oxen. The old man and another woman irrigator who are in the same block indicated that cash, oxen and labor to be the major determinants of effective irrigation. According to their view pump operation and maintenance expenses are considerable which minimized the benefits from irrigation.

There must be saving culture which is explained by one of the key informants. Some people do not use properly their income. Even there is a probability to be susceptible to HIV AIDS and the like due to increased income from irrigation.

4.6. Regression Result

A dependent variable is selected to study factors that determine effectiveness of small scale irrigation schemes at household level. In the model the impact of irrigation on the living standard after participating in the project compared to before the project is used as a proxy to measure effectiveness of the scheme at household level. This is mainly by assessing the perception of the households in changes in magnitude or quality of asset holding such as housing condition, oxen, milking cows, and cash at hand or deposited at Bank access to social services such as schooling of children and increased stock of household assets.

This is based on the Key informant interview regarding how the benefit from irrigation is measured which is explained in terms of oxen bought, constructed corrugated iron sheet houses and motor pumps owned to use on other irrigation plots.

4.6.1. Factors Determining the Probability of Households Improvement after the Project

Respondents were asked if their livelihood at household level has improved because of the irrigation project. Tables 11 and 12 characterize the two groups of households with respect to some of the socioeconomic attributes.

Table 9: Characteristics of improved and unimproved Households after Irrigation

Characteristic	*Improved*		*Unimproved*		t-statistics
	Mean	SD	mean	SD	
Age in years	42.5	13.2	37.7	12	0.203
Family Size	5.7	3.05	4.6	2.04	0.148
Active labor	3.7	2.2	3.1	1.25	0.273
Oxen	2.35	3.43	0.37	0.6	0.016*
Livestock(TLU)	4.2	5.91	1.03	1.06	0.027*
Total land Holding	1.94	1.33	1.3	0.99	0.08**
Size of irrigation plot	0.59	0.37	0.4	0.12	0.04*

Source: Survey Data

*significant at 5%

*significant at 10%

The significant t values indicate that there is a difference between improved and not improved respondents for the variables under consideration. The difference is statistically significant and the probability that the difference happened by chance is rare. For instance variation in oxen, livestock, total land and irrigable land holdings are statistically significant.

Table 10: Characteristics of improved and unimproved families for some of the qualitative variables

Characteristics		*Improved*		*Unimproved*		X^2 *statistics*	*Sig.*
		N	%	N	%		
Education	Illiterate	14	45.1	10	52.6	7.505	0.112
	Adult	6	19.4	0	0		
	Primary	8	25.8	6	31.6		
	Secondary	3	9.7	1	5.3		
	>Secondary	0	0	2	10.5		
Private Pump		6	19.3	1	3.2	1.943	0.182
Participation	Yes	26	83.9	14	73.7	0.764	0.382
	No	5	16.1	5	26.3		
Leasing plot	yes	6	19.4	8	42.1	3.024	0.082
	No	25	80.6	11	57.9		

Source: Survey Data

A relationship is indicated by x^2 value but the strength and direction is not. A low significance value typically below 0.05 indicates that there may be some relationship between the two variables.

A logistic regression was used to identify factors characterizing households' perception of their status of livelihood after participating in the project system. A dummy variable was introduced to categorize those households who felt that their livelihood has improved and those who either felt unchanged, worsened or unknown.

Hence: Di=1, if households perceived an improvement in their livelihood; 0 otherwise. Respondents who perceived their living condition unknown are considered as not improved like those who perceive unchanged or worsened because we are not assured regarding their living condition after the project. Or in other words the impact of the irrigation project on their livelihood is not recognized by these groups.

Multi-co linearity test

Before estimating the regression model it was found necessary to check the functional relationships between the explanatory variables. There is correlation between live stock number and number of oxen, active labor force in a family and family size depicted by large R^2 and hence coefficient of correlation. Family size and number of livestock owned are dropped from the model.

Otherwise it was found that there is no serious multi-collinearity problem among the continuous variables using the tolerance and Variance inflation factors. The values of the contingency coefficient, which basically ranges between 0 and 1 are significantly small. Low value of contingency coefficient indicates absence of serious multicollinearity problem between the considered discrete variables.

After checking and adjusting multi-collinearity, a logit model was estimated using maximum likelihood estimation procedure of the SPSS computer soft ware. Accordingly the model correctly categorized the probability of households that improved and not improved in their livelihood after participation in irrigation in about 86% of the cases. Moreover, the X^2 statstics indicates that the explanatory variables taken together are significantly different from zero at 1% level of significance. Ten of the explanatory variables are found to be important in explaining the dependent variable from a total of fourteen.

The following table summerizes the results of binomial regresion.

Table 11: The maximum Likelihood estimate of The Bionomial Logit model

Livelihood Improvement(Dependent variable)	Estimated Coefficient	Odds ratio	Wald Statistics	P-value
SEXHH	-1.479	0.228	0.704	0.401
AGHH	-0.073	0.930	0.497	0.481
ACTIVLA	0.019	1.019	0.001	0.982
EDUCATIO	0.139	1.149	0.029	0.864
OXEN	2.845	17.198	6.111	0.013**
PRODUCTI	0.124	1.133	3.406	0.065***
IRRIGATI	6.476	649.406	1.870	0.171***
QUANTFER	0.861	2.365	2.038	0.153***
QUANTCHE	-0.206	0.814	0.102	0.749
FARMTOOL	-0.035	0.966	0.003	0.953
SUFFIOUT	0.519	1.680	0.167	0.683
PARTICIP	0.072	1.075	0.001	0.974
OWNMGT	0.420	1.522	0.045	0.832
DEGREFFE	0.651	1.918	0.038	0.845
CONSTANT	-7.815	0.000	1.173	0.279
Pearson-X^2		39.049		0.000*
Correctly predicted		86.0%		
Sensitivity		87.1%		
Specificity		84.2%		

***Significant at 10% probability

**Significant at 5% probability

* Significant at 1% probability

Number of active labor in a family,educational status of the household head,number of oxen owned, level of output from rain fed farming, size of irrigation plots, quantity of fertilizer procured and applied, producing sufficient out put, participation during planning, self cultivating of plots and adequacy of service provision found positively affecting the probability of households perception of improvement in living standard after irrigation as expected. Oxen number holding and level of output from rain fed are found statstically significant.

Number of active labor in a family: This variable has increased the odds ratio of improvement in living standard with irrigation as expected. Irrigation is labor intensive. Those households with high proportion of active labor in a family benefit more from irrigation practice.

Educational Status of the household head: The role of education in increasing production and productivity is considerable. Educated people can understand instructions such how and when to apply water, apply inputs such as fertilizer and chemicals, what to produce and when and where to sale outputs and hence benefit accordingly. The result of the logistic model indicate that as number of years at school increase, there is a chance to get improved from irrigation practice.

Number of oxen owned: This is entered as a numeric variable measured at scale level. Oxen are the main sources of traction power in our country. Pair of oxen is required to pull traditional plow made of wood and steel materials for tillage. Plots need a minimum of three times pulverization for seeding and planting. The size of plots cultivated and number of times plowing are directly related with number of oxen involved in actual cultivation. This variable is significant at 5% probability level which can be interpreted from table 20 above as keeping all other factors constant, the odds ratio in favor of improvement of livelihood after irrigation increased by a factor of 17.2 as the number of oxen increased by one unit.

Level of output from rain fed field: This variable is positively related to impact of irrigation on households since it can directly indicate the position of households to meet the requirement of cash need for irrigation and also surplus for market can be increased from irrigated out put i.e all output from irrigation is not consumed and the odds in favor of improvement from irrigation increase. This variable is also found statistically significant.

Size of irrigation plot in the target area: This variable is one of the variables that positively relate with improvement from irrigation. It indicated optimum plot size is required to bring positive impact on the participating households. The maximum irrigable land holding is 1.5ha and the minimum is 0.25ha. The mean value is 0.48ha.It is required for a household to own a maximum 0.5ha based on Oromia Rural Land Proclamation No 52 (1994) but implementing this proclamation become a challenge at every irrigation scheme. This variable is statistically near significant at 10% probability and taking into account the magnitude of other parameters such as the coefficient and odd ratio.

Quantity of fertilizer Procured Annually: It is positively related to improvement in living standard as expected since using improved practices can result in increase in production and productivity. On the other hand increased cost of fertilizer can increase cost of production and reduce total benefit and hence income accordingly. However, in this model the use of more quantities of fertilizer increased the odds ratio of the probability of improvement in living conditions with irrigation practice. This variable is also near significant at 10% probability and taking into account the magnitude of other parameters such as the coefficient and the odd ratios.

Producing sufficient output for the family: Those households who do not produce adequate food grain perceive the impact of irrigation to be considerable than those who produce adequate food grains may be by cultivating more land or what so ever.

Participation During project Planning: This variable also positively related with improvement from irrigation practice as hypothesized. It indicates the importance of involving the beneficiaries of irrigation at every stage of project cycle which is getting emphasis these days.

Own management of Irrigation Plot: Irrigation practice needs investment of resources including land, labor and financial resources. It is intensive agricultural activity. Specially pump irrigation needs in addition to major factors of production running costs in terms of fuel or electric power to run the pump. Too often resource poor and the destitute such as female headed and the elderly lack such resources and obliged to lease out their irrigable plots to others and this minimizes the net benefit from irrigation by such groups. The result of this study also confirmed this preposition. The probability that households living standard improved is positively related with cultivating own plot rather than leasing it out. Or in other words the logistic model indicates that there is a chance of getting improvement from irrigation practice when households cultivate themselves rather than rent it out, share crop or what so ever leasing arrangement.

Perception of Adequacy of extension and other Services (Access to such services): households who rate good or very good in three or more of the five services are given a value of one and zero if not. This dummy variable is related to the dependent variable and show positive relation ship. This means that those households who are access to modern information and modern practices benefited more from irrigation practice and hence improve in their living standard.

5. Conclusions and Policy Implications

Rain fed production become unreliable to sustain livelihoods in rural areas because of decreased in amount and distribution of rainfall caused by changes in climate. There is computation for water among different uses on the other hand. There fore there is a need to revisit the existing water policies especially in relation to irrigation activities. Research is needed to identify major problems of the sector. This study is one such an attempt directed towards identification of major constraints of communal small scale irrigation activities.

The rainfall pattern is characterized by erratic nature which calls for irrigation not only as a solution to supplement rain fed production but also to diversify income in the study area. Irrigation is feasible to absorb the increasing land less socioeconomic groups in the study area where the demand for arable land is increasing. The average arable land holding is estimated to be 1.7ha which is not adequate especially with inadequate rain fall. About 40% of respondents do not produce sufficient output with rain.

It was identified that the project under study is one of the small scale communal schemes implemented in central rift Valley of Oromia region in 1990s by World Vision Ethiopia. The main involvement of the NGO in the area was provision of relief service. However to bring sustainable changes in the area in which the people become self sufficient in food crops irrigation was found to be the only option in the area. Harvest of cereals such as maize, teff and sorghum did not exceed 6quintals/ha before irrigation. Under the irrigation practice maize and vegetables like onion and tomato are produced. Productivity is substantial compared to with no irrigation case. In general production is intensified and income is diversified with irrigation.

There is problem of fluctuation of user members seemingly due to land entitlement problems. The fact that there are plots which are not irrigated because of difficulty of managing large plots by a household contributes to a large extent to lack of effective performance of the scheme. The result of assessment of plot acquisition suggests that there is limited opportunity to acquire plots in terms of plot exchange outside family members as only 6% of the respondents become a member through land exchange. This needs not only clear irrigation land policy to maximize benefits from irrigation but clear procedures and guiding principles in implementation of the policies so that there could be equitable distribution of resources.

Problem of managing common property is indicated to be one of the factors of lack of effectiveness. As result small members of pump ownership if not individual seems a feasible strategy or the way out. The number of individual pump operators is increasing in the study area because of their efficiency and manageability. Solving and improving organizational problems of the WUA by improving and implementing internal bylaws is needed.

Technological compatibility is identified as one of the determinants of effective irrigation performance. Locally manageable technologies such as simple diversion structures should be given priority before any other mechanized systems. The scheme users also complain about paying for electric city even when they are not using the power such as during rainy season; but according to the corporation the installed meter is active and reactive type which is installed in any industry or business firm. The reactive one gauge even when the pump is not operating. They advised full capacity use of the system. That is benefit increases with increasing scale of operation.

About 57.1% of lack of utilization of the resource is attributed to technical factors such as topography and pump capacity. Land entitlement problems also do have the share. It was also known that the remaining 60ha of land is not fully brought under irrigation at different seasons. This study attributed household characteristics and some socioeconomic factors for under utilization of the scheme and much of this study is devoted to assess the impact of small scale irrigation schemes at household level which is used as a proxy to assess effectiveness of small scale irrigation schemes and major contributing factors for their effective performance.

Irrigation practice has brought significant changes in living standard of the families based on the responses of 62% of the project participants in which they perceive improvement after the project compared to before the project situation. On the other hand the multiplier effect of irrigation practice is depicted by expansion of employment opportunities.

The results of binomial logistic regression indicate that factors such as active labor force in a family, educational status of the head of the household head, oxen possession, total out put from rain fed field, size of irrigation plots , use of improved practices in this case quantity of fertilizer procured and applied, implementing irrigation where there is demand for it in this case depicted by insufficient out put, involving community when planning and designing irrigation, managing own plot rather than leasing it out last but not least adequacy of support systems such as rural credit schemes and extension services are found to be important policy variables that determine effectiveness of irrigation project.

Distance of plots from the water source is mentioned to be one of the factors of effectiveness from the focus group discussion specially this seems valid of pump schemes which require running costs to deliver water. The results of this study also revealed that the variation in crops types cultivated to a larger extent determine the gains from irrigation practice. That is those who manage high value crops such as onion benefit more than those which grow subsistence crops like maize. However the former requires capital investment to procure inputs such as fertilizer and chemicals for crop protection which differentiate the groups.

Access to market information and credit services are found to be not adequate by a good proportion of the respondents. This indicates improving such services in relation to irrigation practice.

Lack of working capital in the form of cash and oxen are identified as major factors that oblige resource poor households to lease out their irrigated plot. This minimized the gain from irrigation practice of such households and contributing towards lack of effectiveness of small scale irrigation.

Availability of fertilizer during dry season limited its use for irrigated crops. Capital is also a determinant of using the input. This implies provision of inputs especially fertilizer and chemicals at main season of irrigation schemes is required. Credit service is also recommended for procuring such inputs and also others for effective performance of small scale irrigation schemes in general and Batu Degaga project in particular.

In the past paying bills was the major problem of the scheme. Lack of market for onion in one of the years discouraged farmers and production was ceased in the year that followed. Currently due to better price for agricultural products in general and irrigated crops in particular enabled

WUA members to pay financial obligations. This implies provision of market information and facilities has to be given special attention while planning irrigation projects.

In general from this study a number of policy issues can be drawn. Few of them are summarized as follow.

1. Irrigation planning should take into account both the technical and human factors. Erroneous project planning and designing must be avoided. Involving the stakeholders specially the beneficiaries was found crucial.

2. Possession of oxen number differentiated improved and unimproved households significantly. Special emphasis has to be given in land preparation and planting. Provision of credit for oxen purchase and access to farm tools for irrigators is areas of interventions.

3. Access to land was found to be one of the constraints that limit effective performance of the scheme. In some cases command area of irrigation is owned by few people. Here only few plots are cultivated. Clear policy with implementation procedures are needed to distribute the resources of land and water equitably at each communal irrigation schemes.

4. Technological incompatibility is also one of the limiting factors. Priority has to be given for locally manageable technologies.

5. Resource poor farmers phase shortage of capital to pay for running costs and to pay maintenance fees. Provision of credit service with implementation of irrigation is necessary.

6. Management of group property is also seen as a problem because of variation of the members in different aspects. The problem is manifested in water distribution equitably, fee collection on time and the like. Organizational issues has to be given due emphasis. There must be clear internal bylaws, rules and regulations and follow ups. Optimum members size seems a feasible strategy specially in relation to pump schemes.

7. Saving culture should be encouraged among irrigators as a security in time of fluctuation of prices of irrigated crops and hence income from irrigation.

8. The existing pumps should be replaced and the structures rehabilitated through participation of all stakeholders at least to maintain the current benefit.

9. The organizational and management capacity of the users must be enhanced and improved.

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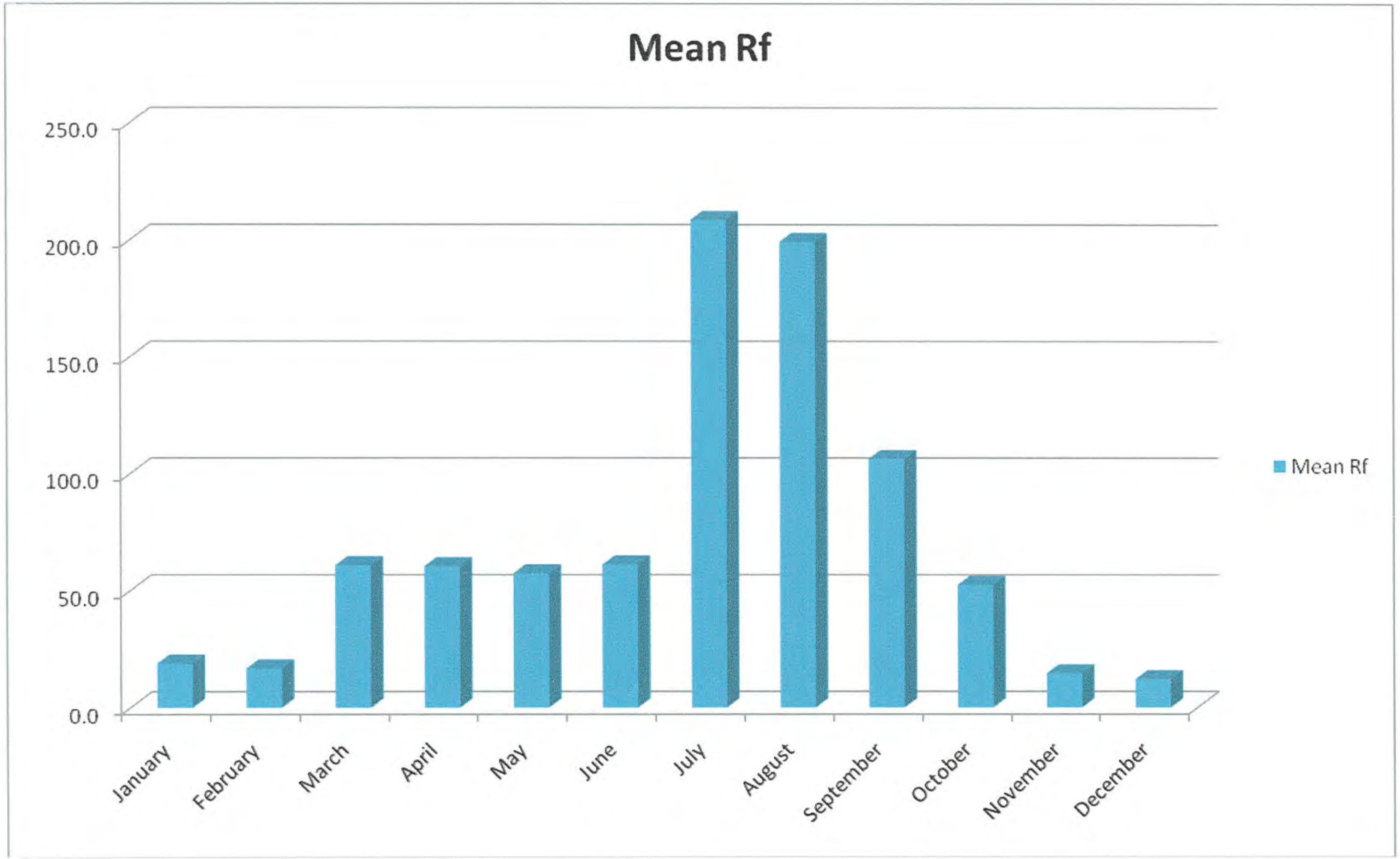
Annex

Annex1-Irrigation Potential in Ethiopia by River Basin

No	*River Basin*	*Potential irrigable*		*Irrigated Area(Ha)*		*Mean Annual Flow(BM^3)*
		area	%	Area	%	
1	Tekeze	189500	5.6	12270	6.5	8.2
2	Abay	1001550	29.4	36010	3.6	52.62
3	Baro-Akobo	600000	17.6	11000	1.8	11.81
4	Rift-Valley	139300	4.1	12270	8.8	5.63
5	Genale-Dawa	600000	17.6	80	0.01	5.88
6	Wabeshebele	204000	6	20290	9.4	3.16
7	Awash	206000	6.1	88000	41	4.6
8	Omo-Gibe	348000	10.2	34800	10	17.96
9	Mereb	37560	1.1			0.26
10	Ogaden	72121	2.1			
11	Aysha	2223	0.1			
12	Dankil	3300	0.1			0.86
	Total	**3403554**	**100**	**214720**	**6.3**	

Source:IDCOF

Annex2: Bar graph showing Monthly Rain fall distribution



Annex3: Total Rain Fall in mm based on AMARC Station

Year	Total Rainfall in mm	Remarks
1998	1040.9	
1999	786.2	
2000	850.4	
2001	814.8	
2002	512.6	
2003	895.9	
2004	790.9	
2005	848	
2006	918.6	
2007	1064.7	
2008	1045	

Annex4: Mean monthly Rain Fall of 11 year (1998-2008) Based on AMARC Station

Month	*Monthly mean Rain Fall(mm)*	*Remarks*
January	18.9	
February	16.8	
March	60.9	
April	60.5	
May	57.5	
June	61.2	
July	208.9	
August	199.5	
September	106.4	
October	52.5	
November	14.6	
December	12.1	

Annex5: Temperature data Based on Five year Data obtained from AMARC

Mean of minimum and maximum by year

Year	***Temperature in °C***	
	minimum	***maximum***
2003	14.2	28.6
2004	14.3	28.6
2005	13.8	29.3
2006	14.7	29.1
2007	14.1	28.7
2008	13.6	28.7

Mean of Monthly Maximum and minimum Temperature for the last five years (AMARC)

Month	Temperature (°C)	
	Mean of Minimum	Mean of Maximum
January	13	28.2
February	13.7	29.9
March	14.3	30.7
April	15.7	30.1
May	15.6	31.8
June	16.9	29.9
July	16.3	27.3
August	15.9	26.7
September	15.3	27.6
October	11.9	28.7
November	11	28
December	10	27.3

Annex 6: Estimation of TLU

No	Type of domestic Animal	TLU value
1	Cow	1
2	Heifer	0.6
3	Young Bull	0.6
4	Calf	0.1
5	Camel	1.43
6	Horse	0.8
7	Mule	0.7
8	Donkey	0.5
9	Goat or Sheep	0.1
10	Chicken	0.01

Source: (Werkineh andRoth, 2002)

Annex7: Trends of total cultivated land, out put produced and Productivity in Adama District

Year	Area(000/has)	Out put(000'quintales)	Productivity (Quintales)	Area growth rate (%)	Output growth rate (%)
1998	25.5	366.1	9.3		
1999	28.5	340.8	12	10.53	22.50
2000	30.3	430.7	14.2	5.94	15.49
2001	30.3	417	13.8	0.00	-2.90
2002*	32.2	92.1	2.9	5.90	-375.86
2003	32.7	493.4	15.1	1.53	80.79
2004	31.7	814.8	25.7	-3.15	41.25
2005	31.7	411.2	13	0.00	-97.69
2006	30.7	928.5	30.2	-3.26	56.95
2007	31.4	998.6	31.8	2.23	5.03
2008	31.3	1022.1	32.7	-0.32	2.75
Average				1.5	13.8

- The value for the year 2002 is found to be outlier and not included in the computation.
- Growth rate in(%)=$(X_t$-$X_{t-1})/X_t*100$, Where X_t is value in year t and X_{t-1} is value of the year before t

Annex8: Survey Questionnaires Prepared for Assessing Effectiveness of Irrigation Schemes (Case Study of Batu degaga)
Part I Check List for all Households

No	*Name of HH head*	*Sex*	*Age*	*Family size*	*No of oxen*	*Land holding size(ha)*			*Private pump (owned or not)*
						RF	Irr.	Tot.	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
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21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

Part II for Selected Households

General Direction: This questionnaire is designed to study the effectiveness of small scale irrigation schemes based on Batu Degaga project. The information provided is not used other than the research under consideration. The researcher would like to appreciate and thank the respondents in providing reliable information. The result of the study could be used as input in identifying and solving major constraints associated with irrigation schemes.

Name of Interviewer________________________

Language used in Interview________________

Date of interview____________

Time started___________Time completed______________

Section I Basic Data of the household

1.1. Name of Household head _____________________

1.2. Sex _____

1.3. Age ______

1.4. Ethnic____________________

1.5. Religion___________________

1.6. Family size_________

1.7. Number of active labor force in the family (10-65 years)__________

1.8. Educational Status of Household head

a) Illiterate b) Attended adult education

c) Primary education (1-8)

d) Secondary education (9-12)

e) Beyond secondary education

Section II Resource Endowment and Livelihoods

2.1. Livestock possession (List type of species you Owen)

No	Name of Species	Number owned	Remark
1	Oxen		
2	Cows		
3	Heifer		Raada
4	Young bull		Jibicha
5	Calf		Jabbii
4	Sheep		
5	Goat		
6	Donkey		
7	Horse		
8	Camel		
9	Poultry		

2.2. Total Land holding __________ha

a) Major Rain fed crops and Production

Crop	Area cultivated	Production	Unit price	Total value

b) Major irrigated crops in the command area

No	Type of Crop	Area cultivated(Average of five years)	Annual production	Unit price	Total value
1					
2					
3					
4					

2.3. Do you have other plot for irrigation? a) Yes b) No

2.4. If the answer is yes for the above question the plot is

a) rented in b) rented out c) self managed d) share cropped

2.5. Size of the plot is _________ ha

2.6. Do you have your Owen private pump? a) Yes b) no

2.7. Farm input utilization by the household

2.7.1. For which crops you apply fertilizer

1) Rain fed 2) Irrigated 3) Both 4) Do not apply

2.7.2. Quantity of fertilizer purchased annually by the household on average _________quintals

2.7.3. What are the main constraints to use fertilizer for irrigated crops?

1) Unavailability during dry season 2) shortage of capital 3) No need of fertilizer

2.7.4. Which agrochemicals you use for crop protection?

a) Herbicides b) insecticides c) fungicides d) all e) none

2.7.5. Quantity of chemicals applied annually in liters_________

2.7.6. Which crops demand more chemical use 1) Rain fed 2) Irrigated

3) The same

2.7.7. Do you get improved varieties of irrigated crops? If yes from where do you get them?

2.7.8. Which farm implements you own?

2.8. Do you produce sufficient output for your family using rain fed?

a) Yes b) No

2.9. If rain fed production is not enough what are the coping strategies?

a) Irrigation practice

b) Relief food and safety net programs

c) Off farm employment

d) Sale of live stock

e) Sale of forest products

(Multiple responses is possible)

2.10. Have you or any of your household received food aid in the last 12 months? a) Yes b) no

2.11. What are the off farm activities available?

a) Petty trade

b) Selling of wood products

c) Working on private plots (Irrigation)

d) Working at state owned farms

e) Others

(Multiple responses is possible)

2.12. What are the three most important problems that negatively affect your crop production?

1st [ ] 2nd [ ] 3rd [ ]

a) Shortage of land b) Lack of fertilizer c) Lack of improved seed d) Lack of fertilizer and improved seed e) Lack of knowhow f) Lack of credit g)Lack of oxen h) inadequate rain fall

Section III Questions related to the scheme

3.1. Have you participated in the planning of Batu Degaga scheme?

1) Yes 2) No

3.2. What were your contributions if your response is yes?

a) Idea b) Free labor c) In cash d) Food for work

e) Cash for work f) Supply of local materials g) No contribution at all

(Multiple responses is possible)

3.3. Are you a member of WUA from the very beginning? 1)yes 2)No

3.4. How did you join BD WUA?

a) Having own plot in the target area b) Through land transfer (Inheritance)

c) Land Exchange d) Renting in of plot e) Crop Sharing

3.5. The size of plot in the command area initially __________ha

3.6. Do you rent out your plot in the command area? a) Yes b) No

3.7. If yes reasons for renting out the plot

a) Shortage of labor
b) Shortage of oxen
c) Shortage of capital and hence difficulty of paying various expenses
d) Lack of market demand and hence low benefit from irrigation
e) Lack of know how in irrigation farming
(Multiple responses are possible)

3.8. Are you secured regarding the ownership of plot in the command area? a) Yes b) No

3.9. You produce for a) Sale b) for home consumption c) for both

3.10. Where do you sell your irrigated product?

a) In local markets b) To merchants coming to field with truck c)both

3.11. Have you paid for pump depreciation so far? a) Yes b) No

3.12. If not reasons for not paying?

a) There is no agreement to pay for replacement

b) Low income from irrigation

c) Weak did not request

3.13. Willingness to pay for replacement a) Positive b) negative c) Unknown

3.14. Who should replace the capital equipment? a) The beneficiaries b) the government c) the implementing NGO

3.15. Regarding the following services try to gauge their effectiveness in relation to irrigation practice based on the levels of measurement given? 1) Very good 2) Good 3) Not good 4) Bad 5) Very bad 6) Have no idea

a) Advice on marketing issues b) Credit service

c) Agricultural inputs (seed, fertilizer, chemicals) d) Advice on water management

e) Training on pump operation

3.16. What are the three most important factors that determine effectiveness of irrigation practice?

1st [ ] 2nd [ ] 3rd [ ]

a) Technological incompatibility b) Access to land resources c) Know how d) Input and out put markets e) organizational problems such as managing common property f) Institutional problems such as support systems h)Lack of working capital

3.17. How can you explain regarding your living condition after participating in the project?

a) Improved b) remain the same c) worsened d) unknown

Topics for Key informant Interview (WV, Irrigation department, Development workers, local leaders)

1. How was this project planned and designed?
2. Level of community participation during planning and implementation
3. What are the main constraints with Batu Degaga scheme?
4. Planned area and beneficiaries, Actual area and beneficiaries major reasons for disparity
5. Were other sources of energy other than electric power considered?
6. Is covering operation expenses and cost recovery expected from the beneficiaries?
7. Support systems in relation to irrigation (Extension, Credit, input supply, marketing etc.)
8. Problems related to water distribution scheduling
9. Problems related to paying financial obligations
10. How much and terms of payment of different expenses
11. How can the impact of irrigation practice explained?
12. existing internal by laws (Punishing violators etc)
13. How can be benefits from irrigation maximized?
14. Is WUA in a position to replace the capital equipment?
15. Can we say that this scheme is successful?

Focus group Discussion

1. What are the main challenges you faced during the project life time?
2. Do you get water properly?
3. How you manage your plot in the command area?
4. How can you measure the benefit from irrigation?
5. Which crops you grow mostly and why?
6. Which type of irrigation technology is preferable?
7. Have you encountered problem of market demand for irrigated out put and when?
8. Is there a year/season in which you did not produce using the scheme? If yes what were the reasons?

Annex9- Restructuring of Organ Responsible for Irrigation in Oromia since 1994

From January1994 to June 1995- Irrigation is one of the departments in ONREPB. The main activities are study, design and construction. The zonal offices are responsible while the head office does the coordination. There are no significant construction activities undertaken during this time.

From July 1995 to June 1999- irrigation is one of the departments under OWMERDB. The main activities are study, design and construction. Twelve Oromia zones are responsible for the activities. Again the head office at Addis Ababa plays the coordination and directing role.

From July 1999 to June 2004 irrigation in Oromia is organized as Authority and OIDA is established. The zonal offices are dissolved and there are four branch offices who undertake and organize study, design, construction, supervision, extension and water management activities. Wereda offices mainly doing the extension and water management become operational. Development agents with diploma are employed to support WUAS at some modern SSI schemes.

In the year 2004 the construction department and section at head office and branch level respectively are separated from OIDA and made to OWWCE.

From July 2004 to June 2005 OIDA is dissolved and become a department under Oromia Agricultural and Rural Development Bureau. The branch offices mainly are responsible for all activities except construction of new schemes. Maintenance activities are also done.

From July 2005 to June 2007 OIDA is again reorganized. The main duties are study, design, supervision and extension to some extent. The branch offices are responsible for study and design and supervision. The zonal office and district offices with limited man power are mainly do the extension and water management activities. In January 2006 OWWDSE which is responsible for study and design of medium and large scale irrigation in addition to the study and design of water supply projects was established and OIDA is responsible only for study of small scale irrigation.

Since July 2007 there is no more OIDA and the branch offices are dissolved. Irrigation is one department under Oromia Water development Bureau. The organizational structures are at Bureau and zonal offices. The organizational structure of district office is not clear.

Annex 10:R^2 value of pairs of continuous variables

Variable	Age	Active	Fsize	Educat	Oxen	TLU	Prodn	Irrig	Chem	Fert	Tools
Age	*	0.301	0.143	0.421	0.102	0.129	0.258	0.047	0.041	0.126	0.007
Active	0.301	*	0.709	0.135	0.225	0.269	0.290	0	0	0.235	0.014
Fsize	0.143	0.709	*	0.077	0.24	0.258	0.239	0	0.014	0.246	0.022
Educatio	0.421	0.135	0.077	*	0.026	0.02	0.130	0.004	0.038	0.001	0.006
Oxen	0.102	0.225	0.24	0.026	*	0.889	0.436	0.009	0.309	0.488	0.114
TLU	0.129	0.269	0.258	0.02	0.889	*	0.403	0.004	0.243	0.496	0.111
Prodn	0.258	0.29	0.239	0.13	0.436	0.403	*	0.002	0.082	0.225	0.059
Irrigati	0.047	0	0	0.004	0.009	0.004	0.002	*	0.191	0.070	0.034
Chemica	0.041	0	0.014	0.038	0.309	0.243	0.082	0.191	*	0.410	0.434
Fertilizer	0.126	0.235	0.246	0.001	0.488	0.496	0.225	0.070	0.410	*	0.238
Ftools	0.007	0.014	0.022	0.006	0.114	0.111	0.059	0.034	0.434	0.434	*
Mean	***0.156***	***0.218***	***0.195***	***0.086***	***0.284***	***0.282***	***0.212***	***0.036***	***0.176***	***0.273***	***0.104***

Source: own computation

Annex11: Multi-collinearity test among Continuous variables

Tolerance and Variance inflation factor (VIF) are used to check the existence of multi-collinearity among continuous variables. Where tolerance (T) =1-R^2, R^2 is the coefficient of determination when each explanatory variables are regressed on each other. VIF is simply the reciprocal of T.

The tolerance and variance inflation factors are estimated as follow.

Variable	R^2	*Tolerance(1-R^2)*	*VIF(1/1-R^2)*
Age	0.156	0.844	1.18
Active	0.218	0.782	1.28
Family size	0.195	0.805	1.24
Education	0.086	0.914	1.09
Oxen	0.284	0.716	1.40
TLU	0.282	0.718	1.39
Production	0.212	0.788	1.27
Irrigation	0.036	0.964	1.04
Chemical	0.176	0.824	1.21
Fertilizer	0.273	0.727	1.38
Farm tools	0.104	0.896	1.12

Source: own Computation

A tolerance level above 0.4 and VIF below 2.5 indicate lack of multi-collinearity among the independent variables. (Vartanian n.d.)Hence from the above table all the variables are with high value of T and low VIF. Some studies suggest a VIF as high as 10 to be indicators of absence of multi-collinearity problem (Bezabih et al, 2002)

Annex 12: Multi-collinearity test among discrete variables

Contingency coefficients were used to see the association between discrete variables. It is computed using Crosstab statistics of the SPSS soft ware.

	SEXHH	Suffiout	Particip	Ownmgt	Degreffe
SEXHH	1				
Suffiout	0.039	1			
Particip	0.257	0.293	1		
Ownmgt	0.098	0.213	0.197	1	
Degreffe	0.192	0.197	0.122	0.044	1

Source: Own Computation

Declaration

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Declared by:

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Confirmed by:

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