AN EVALUATION ON THE EFFECTIVENESS OF HOUSE HOLD IRRIGATION TECHNOLOGIES ON THE LIVES OF FARMERS: THE CASE OF DHUFFA, BERFETE TOKOFFA AND KORE ODO KEBELES IN WELMERA WEREDA, WESTERN SHEWA OF OROMIA,ETHIOPIA

A THESIS SUBMITTED TO THE MASTER'S PROGRAME IN RURAL DEVELOPMENT OF INDIRA GANDHI NATIONAL OPEN UNIVERISITY

/IGNOU/

By

AYELE SILESHI

ID NO: ID1404002

Mobile Phone Number: 251911487112

Advisor: Dr. MULUGETATAYE (PhD)

NEW DELHI, INDIA

May, 2016

ETHIOPIA

DECLARATION

I hereby declare that this thesis entitled ***AN EVALUATION ON THE EFFECTIVENESS OF HOUSE HOLD IRRIGATION TECHNOLOGIES ON THE LIVES OF FARMERS: THE CASE OF DHUFFA, BERFETE TOKOFFA AND KORE ODO KEBELES IN WELMERA WEREDA, WESTERN SHEWA OF OROMIA***submitted by me for the partial fulfilment of M.A. in rural development to Indira Gandhi National Open University, (IGNOU) New Delhi is my own original work and has not been submitted earlier either to IGNOU or any other institution for the fulfilment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

Place: St. Mary University/IGNOU, Addis Ababa. Signature: ----------

Date of submission: May, 2016 Enrolment No. ID 1404002

Name: Ayele Sileshi

Address: Addis Ababa, Ethiopia

CERTIFICATE

This is to certify that Mr. Ayele Sileshi Haile student of M.A (RD) from Indira Gandhi National Open University, New Delhi, was working under my supervision and guidance for his project work for the course MRDP-001. His project work entitled **AN EVALUATION ON THE EFFECTIVENESS OF HOUSE HOLD IRRIGATION TECHNOLOGIES ON THE LIVES OF FARMERS: THE CASE OF DHUFFA, BERFETE TOKOFFA AND KORE ODO KEBELES IN WELMERA WEREDA, WESTERN SHEWA OF OROMIA**which he issubmitting, is his genuine and original work.

Place: Addis Ababa, Ethiopia Signature:

Date: May, 2016

Name: Mulugeta Taye (PhD).

Address of the supervisor:

St. Mary's University College

P. O. Box 1211

Addis Ababa, Ethiopia

BIOGRAPHICAL SKETCH

The author was born on 12 April 1958 in Gohatsion, Shewa. He is the elder of seven children from Ato Sileshi Haile and W/O Mechegiash Work Tolla. He studied his high school education in Fitche Comprehensive High School. He was a participant of the Development Through Cooperation Campaign of the 1975/76.

His higher education studies were all carried out in Colleges and Faculties under Addis Ababa University and begun with a Diploma in Crop Production and Protection from Awassa Junior College of Agriculture (1979), BSc. Degree in Plant Science from Alemaya College of Agriculture (1985), Diploma in Supervisory Management from Faculty of Business and Economics (2002) and a BA in Business Administration from the same faculty (2008) through the extension program.

The author has worked in public and private irrigated farms beginning from 1978 up to 1994 in Afar Region (Amibara, Gewane, Assaita and Dubti State Farms and Private Farms) from the level of a Unit Head to General Manager. He has also worked in Ghibe Valley and Gambella for 3 years at the level of a Farm Manager from a size of 500 hectare up to 6360 hectare of irrigated plantations.

The other segments of work include Expert at National Agricultural Input Authority, Team Leader in the Ministry of Agriculture, and currently Senior Technical Expert in the Agricultural Transformation Agency. Currently, he is enrolled at St.Mary University/IGNOU program to pursue his MA Degree in Rural Development in January 2014.

ACKNOWLEDGEMENT

I express my genuine gratitude to my advisor Dr. Mulugeta Taye for his constant advice, guidance, constructive and critical comments from the very beginning of this work until the final date of submission and his tolerance against my persistent problem of maintaining schedule

My equal and esteemed appreciation goes to Anglo Gulf Private Limited Company (UAE) for giving me the opportunity to pursue my study by covering the tuition fee and expenses required for carrying out my research work. The role that Mr. Sudhir Dalal (GM) played in convincing his management team to arrive at an amicable decision of covering my expenses was an indispensable provision that was denied even from local Ministries I worked for.

I also want to thank my office for understanding the pressure during exams and allow me to take leave or transfer assignments to colleagues so that I can manage my study without much stress.

My special thanks go to Ato Challa Feyissa and Development Agents who have taken the matter seriously and helped me by carrying out the interview and filling the questionnaires as per the instruction provided to them. The research would have been meaningless without their sincere support.

The constant support and advice of St. Mary staff, especially Ato Mossissa Kejella, through his ever open office needs recognition.

Last but not least, I want to thank my wife and children who were there to support and comfort me in my studies, write-ups, typing and editing.

TABLE OF CONTENTS

List of contents

Page

BIOGRAPHICAL SKETCH iv

ACKNOWLEDGEMENT v

TABLE OF CONTENTS vi

ABSTRACT xii

CHAPTER ONE 1

INTRODUCTION 1

1.1. Background of the study 1

1.2. Statement of the problem 10

1.3. Objective of the study 11

1.4. The research questions 12

1.5. Significance of the study 12

1.6. Scope of the study 13

CHAPTER TWO 15

REVIEW OF LITERATURE 15

2.1. Definition of irrigation and concepts related to Irrigation 15

2.7 Small-scale irrigation technologies and adoption 27

2.11 How to improve livelihoods in irrigated areas? 32

RESEARCH METHODOLOGY 36

3.1. Description of the study Area 36

3.1. 1 Location 36

Wolmera Woreda 36

Figure 8: Wolmera, one of the woredas where HHI intervention is being tested 39

Source: ATA, HHI Strategy document 2013 39

3.1.2 Agricultural Activities 39

3.1.3 Socio-Economic Situation 40

CHAPTER FOUR 43

RESULTS AND DISCUSSION 43

CONCLUSION AND RECOMMENDATION 67

5.1. Conclusion 67

5.2. Recommendations 69

References 73

Annex 1 63

Annex 2 70

Annex 3 73

Annex 4 76

LIST OF TABLES

Table No.	Contents	Page No
1	Ethiopian surface water resources by Basin	16
2	Family composition	34
3	Age Structure	35
4	Marital Status, ethnic origin and religion of Households	36
5	Educational level of house holds	36
6	Primary sources of livelihoodand changes	38
7	Change in livestock type & number	39
8	Type and number of water lifting technologies	39
9	Number of times that vegetables are produced	40
10	Number of HH that use HVC and cropping calendar	40
11	Types and quantities of inputs used	41
12	Change in total production & productivity	42
13	Use of saving accounts	42
14	Agreeing or disagreeing on change of livelihood	43
15	Acquisition of training	44
16	Farmers access to agricultural extension service	47
17	Response on level of SMS support to farmers	48
18	Response on the level of DA support to farmers	48
19	Response on the level of Cooperative leaders' support to farmers	48

LIST OF FIGURES

Figure number	Contents	Page Number
1	Major river basins of Ethiopia	4
2	Working modality of ATA	5
3	Strategy of ATA to achieve mandates	5
4	Program Teams of ATA	6
5	How to choose between impact and scale	6
6	Map of the study area, 3 kebeles of (Wolmera Woreda)	30
7	Map of Land Cover of Wolmera Woreda	30
8	Map of 21 HHI pilot Woredas from the 4 big regions	31
9	Sex disaggregated analysis of respondents	35
10	8028 Free Dial service display and contents	44
11	Graph to show the increased use of 8028 extension	45
12	Chart to show the availability of credit	45
13	Chart to show the damage level due to lack of proper storage	49
14	Obstacles in implementing HHI interventions & solutions	50

ACRONYMS

AEZ	Agro-Ecological Zone
AfDB	African Development Bank
AGP	Agricultural Growth Program
ATA	Agricultural Transformation Agency
AWTF	Agricultural Water Task Force
BMGF	Bill & Melinda Gates Foundation
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistics Authority
DAs	Development Agents
DLS	Diffused Light Storage
Etfruit	Ethiopian Fruit and Vegetables Trading Enterprise
FAO	Food and Agricultural Organization of the united nations
FTC	Farmer's Training Centers
HHI	House Hold Irrigation
IFAD	International Fund for Agricultural Development
MOA	Ministry of Agriculture
MoANR	Ministry Of Agriculture and Natural Resources
MoWIE	Ministry Of Water Irrigation and Electricity
NGOs	Non-Government organizations
OIDA	Oromia Irrigation Development Authority

UNIDO	United Nations Industrial Development Organization
WOA	Woreda Office of Agricultural
WFP	World Food Programme

AN EVALUATION ON THE EFFECTIVENESS OF HOUSE HOLD IRRIGATION TECHNOLOGIES ON THE LIVES OF FARMERS: THE CASE OF DHUFFA, BERFETE TOKOFFA AND KORE ODO KEBELES IN WELMERA WEREDA, WESTERN SHEWA OF OROMIA

By: Ayele Sileshi

Advisor: Mulugeta Taye (Ph. D)

ABSTRACT

Although the establishment of Kocha, Boobe and Dhuffa small scale irrigation schemes was in an endeavour to improve the welfare of the people, it remains a pressing issue as economic and social problems continue to affect plot holders which results in the schemes being undermined. The purpose of this research is to assess the impact of House Hold and small scale irrigation on the people's livelihoods in Berfete Tokoffa, Dhuffa and Kore Oddo kebeles. Both quantitative and qualitative methodologies were used in the investigation of the impact of Irrigated Crop production on rural livelihoods. A sample of 90 respondents out of a total of three hundred households was selected using random sampling. Data was collected using interviews, questionnaires and observation. Analyses were done using descriptive statistics. Tables and graphs were employed in presentation and analysis. Results were that House Hold Irrigation interventions along the value chainhaveenabled to create employment, income generation, supply of water throughout the year, improving the feeding habit of the community, acquisition of assets such as local made carts and increased possession of livestock by farmers and school fee generation by the community as a whole. However the

yields produced have not yet addressed the food security situation of households. This is attributed to lack of dependable source of improved seeds, fertilizers and agrochemicals, lack of responsible extension service, inefficient water distribution, price volatility, and lack of storage for the perishable produce, negative role of middlemen, are a few of the causes which negatively affected their desire to produce at maximum capacity. However the intervention by ATA in collaboration with MOA and Holeta Agricultural Research Centre have helped to set the base for a sustainable development based on selected but meaningful interventions influenced by the whole value chain from input provision all the way to marketing of produce to ensure the viability and sustainability of irrigation on rural livelihoods.

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

Ethiopia is a country characterized by persistent food insecurity and deep rural poverty in the midst of abundant natural resources and rich number of working population. Indeed the country represents one of the world's greatest challenges in terms of agricultural development and economic growth (FAO, 2006; Dessalegn et al., 1998; CSA, 2007).

Agriculture is known to be the dominant source of food production and an important sector for sustaining growth and reducing poverty in many developing countries. For Ethiopia, agriculture is the leading sector in terms of income, employment and foreign exchange and national economic growth is determined largely by the performance of agriculture. Irrigation plays a key role in the performance of Ethiopian agriculture. Thus, irrigation may have an important impact on many development indicators for Ethiopia. Irrigation has served as one key driver behind growth in agricultural productivity, increasing household income and alleviation of rural poverty. According to (Haile 2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty, including: i) increasing overall food production and income, which can also reduce food prices, each of which helps poor households meet their basic needs, ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, iii) promoting greater use of yield enhancing farm inputs and iv) creation of additional employment, which together enables people to move out of the poverty cycle.

Agriculture is the mainstay of the Ethiopian economy. It accounts for the lion's share, 46.3% of the total GDP, 83.9% of exports, and 80% of the labor force.Agriculture is one of the pillars of the Ethiopian economy, and the overall economic growth of the country is highly dependent on the success of the agriculture sector.Both industry and services are dependent on the performance of agriculture, which provides raw materials, generates foreign currency for the importation of essential inputs and feeds the fast growing population. (*www.ethioembassy.org.uk/fact%20file/a-z/**agriculture**.htm* accessed on 20/9/2015)

The Government of Federal Democratic Republic of Ethiopia has demonstrated strong commitment to agricultural and rural development through the allocation of over 10% of the national budget (MOA 2013). Within the aim of ensuring food security of its people, the country has developed a clear roadmap of agricultural development investment framework. Irrigation development is one of the key interventions stipulated in the framework, as a means to sustain agricultural growth.

Agriculture in Ethiopia is largely a smallholder phenomenon (Tesfaye, 2003; Alemneh, 2003; Devereux *et al*., 2005; CSA, 2007) and about 37 percent of the farming households in the country cultivate less than 0.5 hectares (CSA, 2007) indicating the sector to host 90 percent of the country's poor (Gebremedhin 2001; Pankhurst and Gebre, 2002; Devereux *et al*., 2005; CSA 2007). Yet the sector is based on subsistence system (Tesfaye, 2003; Alemneh, 2003), who's modes of life and operation have remained unchanged for centuries and both the industry and service sectors of the country are dependent on the performance of agriculture, which provides raw materials, generates foreign currency for the importation of essential inputs and feeds the fast growing population (www. Ethioembassy.org.uk/fact%20file/a-z/agriculture.htm accessed on 20/9/2015).

In Ethiopia, though the practice was rudimentary, irrigation has a long tradition (Kloos, 1990). The terraces of Konso are signs that an advanced water and soil conservation practices used to be carried out by the community in the 17th century. Foreign literature has a rich presentation on this even though it is not possible to get one. One of the main targets of irrigation systems is to avail agricultural production in qualitative as well as quantitative means. (Mengistu, 2003). Harvests shall be enlarged so that people either produce enough food for the non-harvest time or to sell their overproduction and earn some money to buy food. Another opportunity to produce more food crops is irrigated gardening, an activity mainly done by women.

In addition, (Zhou et al. 2009) discussed how irrigation contributes to increased value of agricultural production by increasing crop yields enabling farmers to increase cropping intensity and to produce higher-value crops. Therefore, irrigation can be an indispensable technological intervention to increase household income.

According to the Ex-Ministry of Water Resources of Ethiopia (MoWR, 2002), irrigation development in Ethiopia is classified based on the size of the command area, in three types: 1. Small-scale irrigation systems (<200 hectares ha) 2. Medium-scale irrigation systems(200-3,000 ha) 3. Large-scale irrigation systems (>3,000 ha). This classification system is the most common in Ethiopia. Accordingly, 46% of proposed irrigation developments are in the small-scale irrigation category (Makombe et al., 2011).

Based on its scale of operation, the irrigation system in the country is categorized as: large scale, medium scale, small scale and household irrigation; and implementation mandates are given to different actors of the government. Implementation mandates for large scale (>3000 ha) and medium scale (200 - 3000 ha) irrigation schemes are given to the Ministry of Water,

Irrigation and Energy. Small-scale irrigation is an irrigation practice operated at the level of farmer groups and households on a (5 - 200) ha; and implementation mandate for small-scale irrigation schemes is given to the Ministry of Agriculture.

Household irrigation has a command area of less than 5 ha, for plots of fewer than ten households. Household irrigation is independently managed by households for it does not require sophisticated infrastructure and engineering expertise for both construction and maintenance activities.

Ethiopia comprises 112 million hectares of land. Cultivable land area estimates vary between 30 to 70 Mha. Currently, high estimates show that only 15 million hectare of land is under cultivation. For the existing cultivated area, the estimate is that only about 4 to 5 percent is irrigated. The location of the 9 major River Basins is indicated in the next figure:

Ethiopia's 9 major river basins and corresponding surface irrigation potential

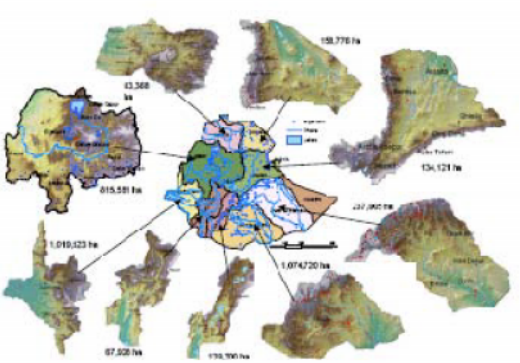

Figure1: Major river basins of Ethiopia

SOURCE: (Sileshi et al, 2007)

Given the abundant surface and ground water resources, a favourable weather that is conducive for production more than twice, its proximity to a renowned Agricultural Research Center, the Woreda/Kebeles have not benefited from all of this. The problem remains in the

attitude of the farmers to get engaged in irrigation that requires a close attention, initial capital and a prospective market. Farmers always try to avoid risk. The extension itself has not adequately demonstrated irrigated production. This led to low production and productivity of small holder farmers.

The Ethiopian Agricultural Transformation Agency (the Agency or ATA) is an initiative of the Government of Ethiopia (GoE), established by federal regulation. The primary aim of the Agency is to promote agricultural sector transformation by supporting existing structures of government, private sector and other non-governmental partners to address systemic bottlenecks in delivering on a priority national agenda for achieving growth and food security.

The Household Irrigation Project, with in the Ethiopian Agricultural Transformation Agency, is designed to support the Agricultural Growth Program achieve its household irrigation targets in AGP woredas in short term and scale it up to national level through small-scale irrigation, primarily household-level manual and engine pump technologies, in partnership with the MOA, Regional Bureaus of Agriculture RBOAs and other implementing partners.

The ATA is a time-bound government organization whose mandate is to:

Support our partners in developing and implementing solutions to systemic bottlenecks in order to transform the agriculture sector, coupled with;

*Supporting the implementation of a targeted set of integrated interventions*that will make immediate impact for a large number of smallholder farmers in Ethiopia

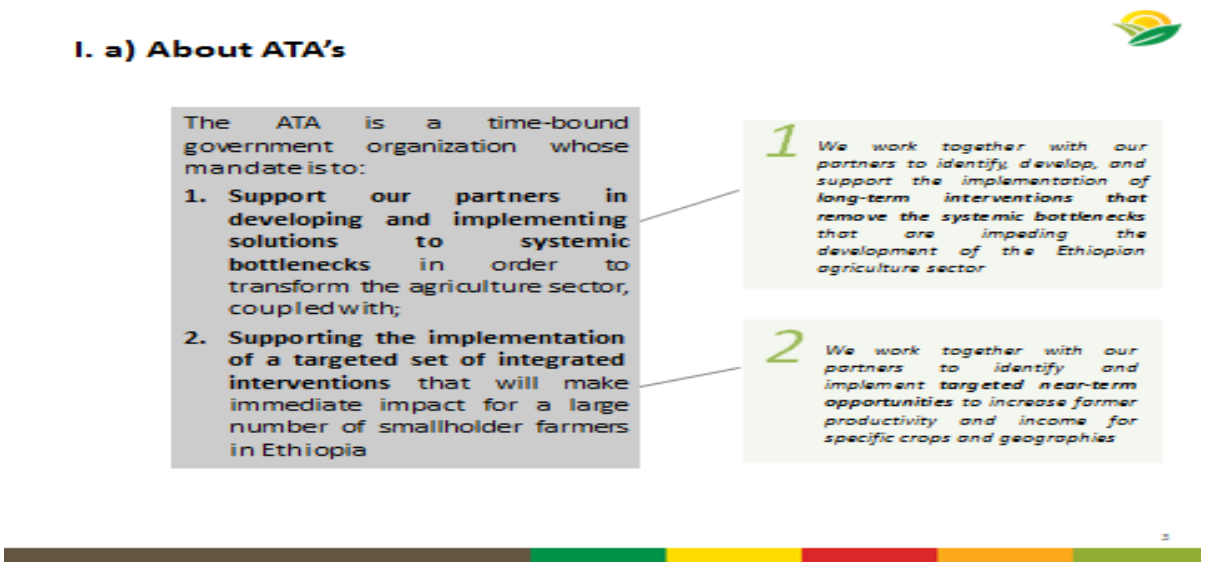

Figure 2: Working modality of ATA with partners

Source: ATA 2013

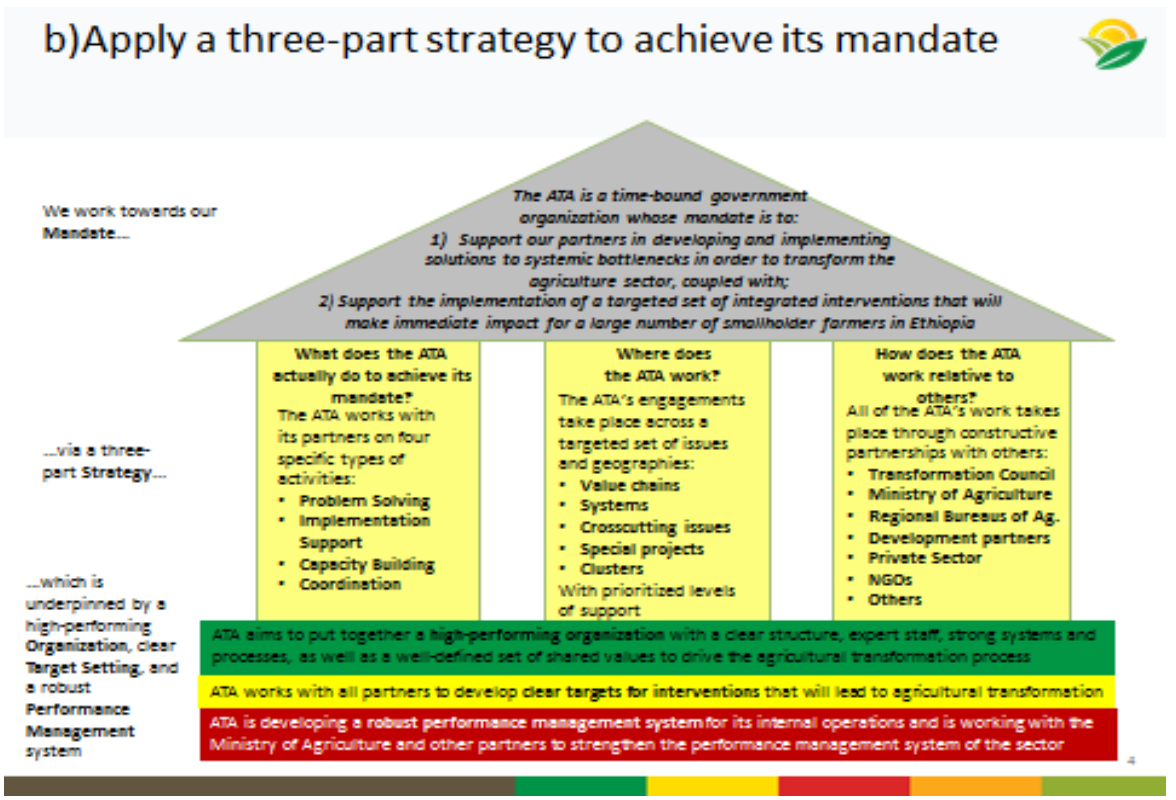

Figure 3: Strategy to achieve mandate

Source: ATA 2013

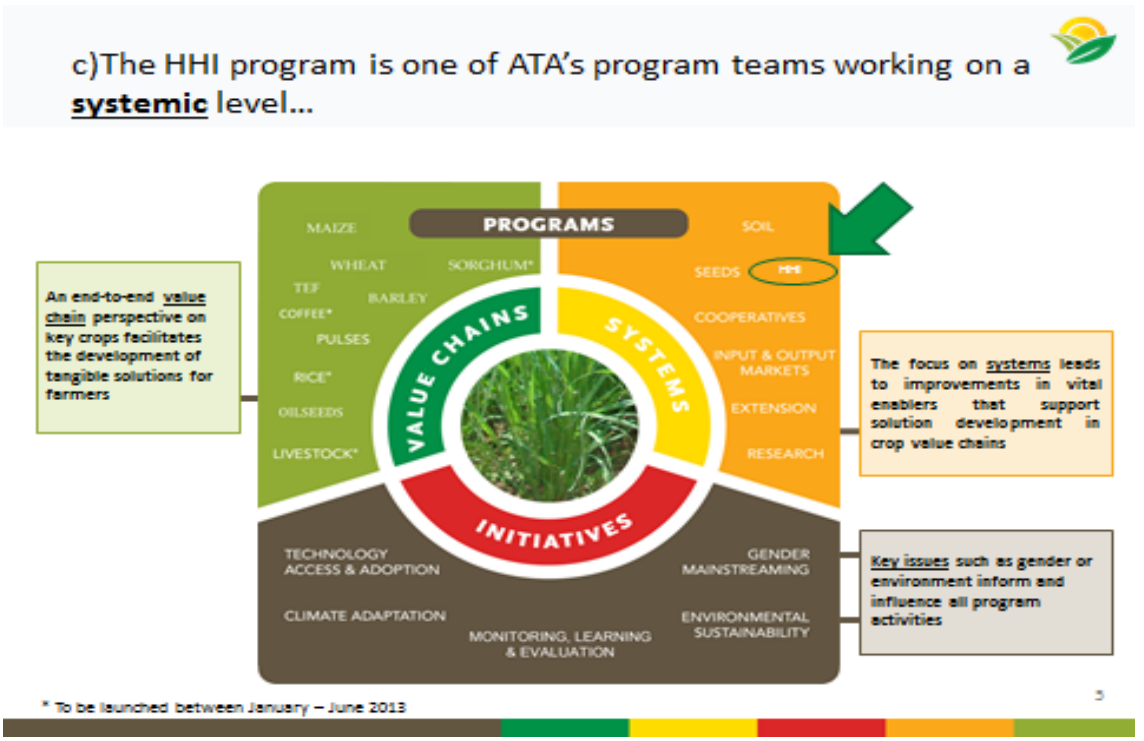

Figure 4: ATA Program Teams

Source:ATA (2013)

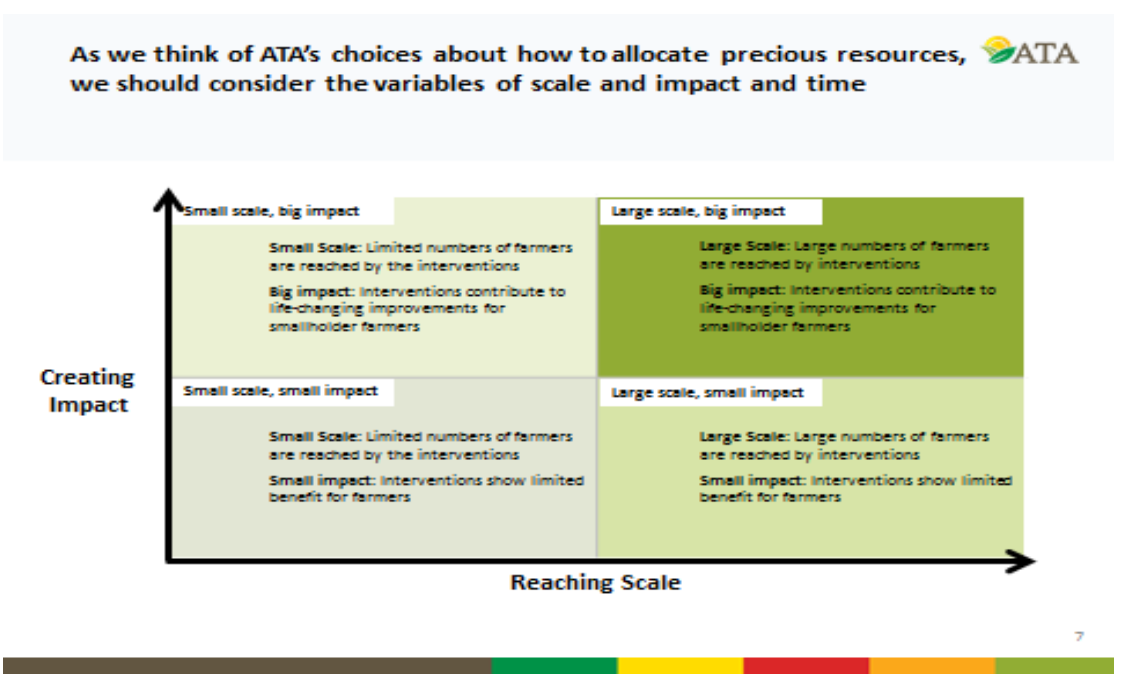

Figure 5 Choice between impact and scale

Source: House Hold Irrigation Strategy. Agriculture Transformation Agency of Ethiopia (2013)

Household Irrigation Program at the Ethiopian Agricultural Transformation Agency engages public, private and non-governmental stakeholders to support strategic planning, strengthen implementation capacity and test innovative models across all the value chains; so as to: (i) increase income of smallholder farmers, (ii) improve their food security throughout the year, and (iii) catalyse growth in farming communities. According to the current working definition of ATA, household irrigation has a command area of less than 5 ha, for plots of fewer than ten households. Household irrigation is independently managed by households for it does not require sophisticated infrastructure and engineering expertise for both construction and maintenance activities.

Household irrigation requires promoting the use of both waterlifting and water-saving technologies, supplying inputs for high-value horticultural crops, applying best practices in agronomy and water management, proper post-harvest handling practices, and ensuring reliable market linkages for the resulting output. Towards this, Household Irrigation Sector Strategy has been designed aligned with the prevailing agriculture and rural development policies and strategies. The strategy helps as a systematic guide to address household irrigation related challenges across the value chains of: (i) Research, knowledge and policy; (ii) technology access & adoption; (iii) Input production, procurement and distribution; (iv) On-farm production; (v) Post-harvest handling; and (vi) Market linkages, and (vii) Demand sinks.

As part of the development community's fascination with the field of appropriate technologies, a range of technologies, techniques and practices have been developed over the years on behalf of smallholders. However, many, if not most, technologies have not been successful in their performance, application, dissemination or adoption. Development

agencies have tried to encourage farmers to adopt bush pumps, rope-and-washer pumps, rower pumps, treadle pumps, pitcher pot systems, drag-hose sprinklers, hydraulic ram pumps, micro-irrigation systems, windmills, water harvesting techniques and a host of other technologies with mixed success. While it may be that some of the technologies simply did not perform up to the expectations, there is a natural tendency to over-emphasize the technology itself rather than pay attention to the process by which it is identified, modified, and disseminated. All too frequently, the end customer - the farmer - has been left out of the process altogether (Jorma,1999).

Small-scale irrigation, defined as less than 200 ha, in the peasant sector has a relatively longer history in certain parts of Ethiopia. Unlike the large-scale irrigation in the basin, however, it has been given little attention on the development, operation (management) and improvement of the sector (EARO 2002).While no reliable data on the area of small-scale irrigation are available, estimates in the Awash Basin indicate a total irrigated area of about20,000 ha (most of which are in the uplands) and it can be expanded to 35,000 ha (Halcrow,1989).More recently small-scale irrigation developments have been gradually expanding through the initiative of NGOs, farmer cooperatives, private investors and individual farmers. According to (McCornick et al 2003),the figure for the potential area of traditional irrigation in the country as a whole reaches around 352 thousand while only 65 thousand hectare is under irrigation.

The availability of irrigation water management information on a detailed scale like farmer fields or for entire river basins is not common. Data to quantify performance indicators are rarely collected (Bastiaanssenand Bos,1999).To make a performance-oriented approach effective, it is necessary to retrofit new techniques and approaches to existing management practices.

One particularly pressing resource management challenge to Ethiopia is to improve the performance of small-scale irrigation systems. These systems will play an important role in providing food for the country's growing population. At the same time, they have the potential to waste, even degrade, vital soil and water resources. In recognition to both the promise and hazards associated with irrigation, evaluating irrigation performance has now become of a paramount importance.

1.2. Statement of the problem

The farmers residing in the fertile plain of the Dhuffa, Berfete Tokoffa and Kore oddo kebeles have been endowed with a fertile land, adequate moisture from the bimodal rainfall, a suitable weather for the growing of different types of crops and livestock and a conducive weather for a healthy living. Despite all these commendable endowments, the farmers in these villages used to run-through a hand- to-mouth style of living.

The annual sales of their agricultural produce do not suffice to lead a modest life. There is no change in their life style and they are forced to remain under the realm of poverty.

This stagnant mode of living could not trigger development of infrastructure either. They were far from schools, health centres, police station and other minimum service providing facilities.

Their children have to go a long way to get elementary education, women have to travel a lot to get water for drinking and sanitation, search for fire wood and go to flour mills.

All of these were due to lack of the exposure to new methods of improving agricultural production and productivity. To get an increased production and productivity, farmers must at

least select the proper high value crop; use improved seeds, appropriate fertilizers, crop protection technologies and post-harvest technologies.

There is also the opportunity for farmers to use house hold irrigation technologies along the value chain that commences with the provision of information, agronomic trainings, agricultural inputs, irrigation water management trainings and arrangement of conducive situations for the marketing of the produce of farmers.

However, empirical evidence about how these participant households contribute to the rural welfare and development of their area on smallholder-based agriculture in Wolmera Woreda is yet scanty and required to perform research or conduct study in order to realize their potential in transforming the traditional rain fed subsistence agriculture into a dependable irrigated cultivation at least producing more than once per year. Therefore, this study has been carried out to provide some new empirical evidence that may help us understand the conditions of participant households in improving their living standards in the study area. This evidence will provide new insights for policymakers, researchers, and development practitioners who are encouraged by the flourishing of house hold irrigation practices along the value chain as a means of benefiting the rural poor.

1.3. Objective of the study

1.3.1. The main objective of the study is to evaluate the assessment of the effect of house hold irrigation technologies in improving the lives of the farmers who are living and cultivating crops.

Specific objectives

a) To evaluate the utilization level of modern agricultural inputs by households in their cultivation of high value crops,

b) To assess the improvement in increased production and productivity,

c) To gather data and evaluate the economic benefit the farmers who participated in HHI in the kebeles have achieved,

d) To check whether the complete process in the house hold irrigation value chain has been implemented and succeeded.

1.4. The research questions

The research is initiated to answer four main questions that persist in the lives of the small holder farmers who have been living in this area for generations. There is the practice of irrigation here and there in its traditional ways of simply applying water to a certain vegetable, fruit tree, ratoon or wild cabbage and green pepper.

Do the farmers practice a major irrigated vegetable production?

Given that irrigated vegetable production is expensive, are the farmers aware that non improved practices reap off their assets?

Do they understand that misuse of the opportunities in an improved irrigation could lead them to disaster?

Have they passed the point of no return to rudimentary agricultural practices?

1.5. Significance of the study

Irrigation as a whole, but particularly house hold irrigation is the most neglected sector in the socio economic relation of rural development. There are no adequate research undertakings and recommendations to be provided to household irrigation participants. The extension agents do not have sufficient knowledge on the operations, management and control of irrigation. Farmers use their own experiences or meagre exposure they have encountered working with NGO's or different sized schemes found in their vicinity.

Cognizant of the fact that many Asian countries have come out of poverty using irrigation, all governmental, private, NGO's and concerned shall give special attention and support to House Hold Irrigation.

Though the government has currently given attention to segregated sizes of irrigation based on their area, there are no assessments and reviews carried out on the performance to take the required action.

Hence it is high time to carry out lots of evaluations on the performance of these house hold irrigation interventions before it is too late to realize that things have gone wrong.

1.6. Scope of the study

The present study is a micro level study limited to one Woreda of western Oromia. The study is confined to the three kebeles; namely: Dhuffa, Bekeka (Kore Oddo) and Berfete Tokoffa which are found in Oromia National Regional State, Finfine zuria Special Zone, Wolmera Woreda which is about 42 kilometers from Addis Ababa.

1.7 Limitation of the study

In the assessment of these areas, certain important features would be taken into consideration. The research will only focus on farmers, cooperative leaders and Development Agents who work in the three kebeles in addition to respondent farmers.

Due to limited time and resource availability, it will not be possible to cover and survey the entire farming population in the Woreda. Ethiopia is a diverse nation in terms of culture, social capital, agro ecology, resource endowment and ethnic groups. Hence, this study cannot be typical or warrant generalizations for the entire country in general, or the region in particular. Yet, recommendations and policy implications of this study could be used in other locations having comparable or similar context (socio-economic characteristics).

1.8. Organization of the thesis

This thesis comprises of five chapters. In the first chapter, the background of the study, statement of the problem, significance of the study, scope and limitations of the study, general and specific objectives, and research questions were included. In the second chapter, review of related literature and operational definitions of variables as well as empirical studies were incorporated. In the third chapter, the methodology part of the study is clearly detailed and in the fourth and fifth chapters the result and discussion, conclusion and recommendations of the study were presented consecutively.

CHAPTER TWO

REVIEW OF LITERATURE

This chapter presents the review of literature on irrigation and irrigated crop production, concepts and definition of house hold irrigation, types of irrigation technologies, irrigated agriculture and its potential for food security, employment creation and overall development.

2.1. Definition of irrigation and concepts related to Irrigation

In doing research operationalizing/giving the operational definitions for the dependent and explanatory variables need to have clear understanding in what the researcher is going to do. Evidence shows that house hold irrigation using manual pumps has enabled farmers be more actively engaged during the dry season and get additional income for their families. So, the impact of house hold irrigation by using improved irrigation technologies in influencing or changing the livelihood assets of farmers was considered and analysed in this research.

Irrigation

In general, irrigation is the practice of providing a sustainable source of water supply for a crop under consideration. It is the supply of water to agricultural crops by artificial means, designed to permit farming in arid regions and to offset the effect of drought in semi-arid regions. Even in areas where total seasonal rainfall is adequate on average, it may be poorly distributed during the year and variable from year to year. Where traditional rain-fed farming is a high-risk enterprise, irrigation can help to ensure stable agricultural production (FAO, 1997).

Hence, irrigation is a means by which agricultural production could be increased to meet the growing food demand. Increasing food demand could be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land and increasing cropping intensity. Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristics of large parts of the country's land and increasing population. Increasing yields in both rain-fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are therefore the most viable options for achieving food security (IWMI, 2005).

Irrigation is thus a valuable insurance. Several crops, such as tomatoes and leafy vegetable, grow far better in the dry season when they do not suffer attacks of mildew or pests prevalent in the wet season, and other crops require the lower temperatures of the dry season. There is also a major advantage in combining dry season and wet season cultivation. The latter is used for the staple crops but the area a family can cultivate is often limited by the labour required during operations like weeding. Dry season cultivation makes deficient use of labour at a less busy time of year. Much FMIS is for subsistence cultivation and improves the diet by providing a supply of fresh vegetable throughout the year, but it is also important as a source of high value crops, providing income when access to roads and markets is possible (Turner, 1994).

According to (Jorge, 1993) irrigation system fall in two broad categories: those in which the principal management responsibility is exercised by government agencies with the farmers playing a subsidiary role, and those in which most management activities are carried out and decision made by the farmers themselves with the government providing periodic technical or logistical support. The latter category in which farmers assume the dominant role is referred

to as Farmer-Managed Irrigation Systems (FMIS). In general, an important characteristic of FMIS is that the farmers also control and manage the water abstraction from its source. Governments often classify these systems as "small-scale irrigation system" or "minor irrigation systems," although examples of FMIS may be found with command areas of hectares. FMIS are also known as traditional, indigenous, communal or people's systems. The precise set of activities and functions that the farmers and their organizations perform varies from country to country and from system to system.

House Hold: A family that is living in a definite residential area usually composed of a husband, a wife, children, hired labourer and other dependants sharing the earnings of the family.

High value crops: Crops that require a significantly higher input, higher focus, better care and protection as they are supposed to give a better yield and finally higher sales.

Vegetable crops: these are crops that are produced on a smaller amount of land, usually near the source of water and not far from residential areas. They require a higher care and give better yield than other types of crops.

House Hold Irrigation Technologies: these are improved agricultural inputs that are directly related to the activities of irrigated horticulture that are anticipated to ease the burden of the farmer, enhance quality production and help increase productivity thereby ensure the profitability of the farmer.

Improved seeds: these are improved planting materials that are imported from abroad or produced with the maximum care and expertise ensuring a high germination and or survival percentage after transplanting

Brokers: are middle men that play a very significant role in linking producers and buyers, always trying to ensure the benefit they reap from both parties at times.

Etfruit: is a parastatal Enterprise mandated to regulate price of vegetables and fruits by intervening in the wholesale as well as the retail market

Contractual Agreement: An agreement signed between two parties to deliver/receive a distinct quantity, volume, quality of a product at a specified/regular period of time for a predetermined or regularly/jointly agreed up on price.

Improved living standard: It is the level of wealth, comfort, material goods and necessities available to a certain socioeconomic class in a certain geographic area. The standard of living determines the factors such as income, quality and availability of employment, class disparity, poverty rate, quality and affordability of housing, hours of work required to purchase necessities, gross domestic product, inflation rate, number of vacation days per year, affordable (or free) access to quality healthcare, quality and availability of education, life expectancy, incidence of disease, cost of goods and services, infrastructure, national economic growth, economic and political stability, political and religious freedom, environmental quality, climate and safety. The standard of living is closely related to quality of life.

Livelihood: In social sciences the concept of livelihood extends to include social and cultural means, i.e. "the command an individual, family, or other social group has over an income and/or bundles of resources that can be used or exchanged to satisfy its needs. This may involve information, cultural knowledge, social networks and legal rights as well as tools, land and other physical resources".A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood

is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the (Carney, 1998).

2.2 Historical Back ground of irrigation

Irrigation has been practiced for at least 5000 years in Egypt and China, 4000 years in India and the Tigris-Euphrates basin and 2,500 years in the central Andes. Large-scale systems were developed under state or royal patronage where there were well-organized social systems and long-term stability prevailed. But small-scale irrigation must be even older. In more recent times, major schemes were developed in India in the late 19th century, followed by other parts of Asia, Egypt and Sudan. These schemes were often seen as an ideal way to increase food production and reduce dependence on the variability of rainfall. They were also prestige developments, and later similar schemes appealed particularly to newly independent countries and attracted large amounts of foreign aid, especially in the 1960s and 1970s (Jorma,1999).

For centuries, agriculture has driven economic growth in countries across the globe, and African nations are following the same path out of poverty. With agriculture accounting for 65 per cent of the continent's employment and 75 percent of its domestic trade, it is likely to drive Africa's economic growth for years to come. Smallholder farmers will be the backbone of that effort. New and evolving markets hold the promise of greater profits for smallholder farmers. Feeding the rapidly growing urban population will require more and higher quality agricultural commodities. Urban consumers will also increase demand for processed agricultural products, so adding value to farmers' outputs will take centre stage in years to come. This will provide lucrative opportunities not just for the women and men who grow the food, but for a wide range of rural workers, especially the emerging generation of young people. A key first step in exploiting these opportunities is recognizing smallholder farms as agribusinesses, regardless of their size or scale. Unfortunately, too many small agribusinesses

in Africa are neither productive nor profitable. There are two significant reasons why they remain trapped in a cycle of subsistence. First, their yields are too low to generate marketable surpluses, because they lack access to modern technology and productive assets. Second, farmers cannot get their produce to markets, because of the lack of roads and linkages between farm-level production and downstream activities, such as processing and marketing. African agriculture and agribusiness must be transformed to meet the demands of the twenty-first century.(UNIDO & GIZ,2008).

2.3 Overview of Ethiopian irrigation

Ethiopia comprises 112 million hectares of land. Cultivable land area estimates vary between 30 and 70 million hectares. Currently, high estimates show that only 15 million hectare of land is under cultivation. For the existing cultivated area, estimatesare that only about 4 to 5 percent is irrigated, with existing equipped irrigation schemes covering about 640,000 hectares. This means that a significant portion of cultivated land in Ethiopia is currently not irrigated. This section examines Ethiopia's water sources for irrigation, current irrigation schemes, and potential to increase irrigated lands.

The premise is that well-managed irrigation development is key in helping Ethiopia overcome major challenges including population pressure; soil and land degradation; high climate variability, and low agricultural productivity. In addition, agricultural water development is crucial to improve smallholder livelihood and income in Ethiopia, since irrigation can help farmers increase their crop production, increase crop variety, and lengthen their agricultural seasons.

As explained in subsequent sections, the study estimates that over the next two decades, Ethiopia could irrigate over 5 million ha with existing water sources, contributing around

ETB 140 billion *per annum* to the economy and ensuring food security for up to six million households (~30 million direct beneficiaries). (IWMI, 2010)

2.4 Water resources and irrigation development of Ethiopia

It is believed that Ethiopia has a total volume of 123 billion cubic meters of surface water and about 2.6 billion cubic meters of groundwater. The distribution is not, however, uniform. The western half of the country receives sustainable amounts of precipitation and has many perennial rivers and streams while the precipitation is marginal in the eastern half of the country.

Table 1. Ethiopian surface water resources by major river basins

No.	River basin Catchments	area (km2)	Annualrun off (10 9 m 3)	Specificdischarge (litres/km2)	Irrigation potential (ha)
1	Abay	199,812,112.00	52.60	7.8	711000
2	Awash	112700.00	4.60	1.4	206000
3	Baro-Akobo	74100.00	23.60	9.7	483000
4	Genale-Dawa	171050.00	5.88	1.2	326000
5	Mereb	5900.00	0.26	3.2	38000
6	Omo-Ghibe	78200.00	17.96	6.7	348000
7	Rift Valley	52740.00	5.64	3.4	46500
8	Tekeze	90000.00	7.63	3.2	302000
9	Wabi-Shebele	200214.00	3.16	0.5	122000
10	Danakil	74000.00	0.86	0 -	

Source: IWMI Diagnostic study of irrigation potential, 2010

The Ethiopian plateau is the source of the Abay, Awash, Tekeze, Mereb, Baro- Akobo and Omo rivers that flow to the west and southwest. The Baro-Akobo basin is potentially the largest possible irrigable area (about 483 thousand hectares) though only a negligible portion of it has been developed probably because of the large investment cost required and its distance from the central market, which makes it less favourable for commercial agriculture. Awash River is the only river extensively used for commercial plantations of industrial and horticultural. Out of the total irrigated area of about 161,125 ha, over 43% is found in the Awash River basin. The remaining potential of the Awash River for irrigated agriculture is in the order of 136,220 ha (McCornick et al, 2003).

If successful, irrigation in Ethiopia could represent a cornerstone of the agricultural development of the country, contributing up to USD 70 billion to the economy and potentially moving up to 6 million households into food security.

However, irrigation is not a simple silver bullet: first, it can only work if other components of the agricultural system are also effective (e.g., seeds, extension); second, all the tools in the toolkit will be required – from small-scale irrigation to large-scale schemes – to construct a viable solution. Like many countries before it, Ethiopia will have to develop its own spectrum of solutions to serve the needs of smallholder farmers as well those of broader economic development.

Ethiopia has an important opportunity in water-led development, but it needs to address critical challenges in the planning, design, delivery, and maintenance of its irrigation systems if it is to capture its full potential. This study shows how Ethiopia can chart a practical path of initiatives that will allow it to support the scale-up of its irrigated agricultural sector, the

growth of its small holder farmers, and the transition of its pastoralist communities to food and water security.(Sileshi B, 2010).

2.5 Perspectives and objectives of irrigation

A reliable and suitable irrigation water supply can result in vast improvements in agricultural production and assure the economic vitality of the region. Many civilizations have been dependent on irrigated agriculture to provide the basis of their society and enhance the security of their people. Some have estimated that as little as 15-20 percent of the worldwide total cultivated area is irrigated. Judging from irrigated and non-irrigated yields in some areas, this relatively small fraction of agriculture may be contributing as much as 30-40% of gross agricultural output (FAO, 1989).

The extensive review suggests that there are strong linkages between irrigation and poverty alleviation. These linkages are both direct and indirect. Direct linkages operate via localized and household-level effects, and indirect linkages operate via aggregate or national level impacts. Irrigation benefits the poor though higher production, higher yields, lower risk of crop failure, and higher and year-round farm and nonfarm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value subsistence production to high-value market-oriented production. The transition to the market economy integrates the poor into land, labour, commodity, and information markets, and it empowers them. Increased production makes food available and affordable for the poor. The poor and landless are the main beneficiaries of low food prices as they are net buyers of food. The indirect linkages operate via regional, national, and economy-wide effects. Irrigation investments act as production and supply shifters, and have strong positive effects on

economic growth, benefiting the poor in the long run. The magnitude of indirect economy-wide benefits could be even more than the direct and local and household-level benefits. Further, irrigation also benefits the poor and landless in the long run, although in the short run relative benefits to the landless and land-poor may be small, as the allocation of water often tends to be land-based. Land-based water allocation is inherently biased against the landless. Despite that, the poor and landless benefit, in both absolute and relative terms, from irrigation investments. Recent advances in irrigation technologies, such as micro-irrigation systems, have strong anti-poverty potential.(Hussain and m. A. Hanjra, 2004)

The method, frequency and duration of irrigations have significant effects on crop yield and farm productivity. For instance, annual crops may not germinate when the surface is inundated causing a crust over the seedbed. After emergence, inadequate soil moisture can often reduce yields, particularly if the stress occurs during critical periods. Even though the most important objective of irrigation is to maintain the soil moisture reservoir, how this is accomplished is an important consideration. The technology of irrigation is more complex than many appreciate. It is important that the scope of irrigation science is not limited to diversion and conveyance systems, or solely to the irrigated field, or only to the drainage path ways. Irrigation is a system extending across many technical and non-technical disciplines. It only works efficiently and continually when all the components are integrated smoothly (FAO, 1989).

There are indications that as much as 80 percent of the required increase in food grain production over the next few decades must come from yield increase. Irrigation could play an important role in achieving and stabilizing such a yield increase. In fact, most of the required increase in food output is expected from the irrigation sector. But one has to recognize that competition from industrial and urban uses is rapidly limiting agricultural water supplies in

many parts of the world, especially in the developing world. Furthermore, energy resources are finite and past experience has shown that irrigated agriculture can lead to land degradation through waterlogging and salinity, depletion of groundwater and surface water quality, fertilizer components and pesticides in return flows, saline water intrusion into ground water, fertility depletion, increase in weeds and pests in irrigated, areas, and/or serious public health problems through an increased incidence of water-borne diseases (Franz Heim and Charles L. Abernethy,1990)

Many countries depend on surface irrigation to grow crops for food and fibre. Without surface irrigation their agricultural production would be drastically lower and problems of unreliable food supply, insufficient rural income and unemployment would be widespread. Although precise data are lacking, estimation of surface irrigation accounts for some 80 to 90 percent of the total 260 million hectares of irrigated land worldwide, mainly in developing countries in the tropics and sub tropics, where hundreds of millions of farmers depend on surface irrigation to grow their crops (Jurriens et al, 2001).

(FAO, 1989) outlined the problems irrigated agriculture may face in the future. One of the major concerns is the generally poor efficiency with which water resources have been used for irrigation. A relatively safe estimate is that 40 percent or more of the water diverted for irrigation is wasted at the farm level through either deep percolation or surface runoff.
Irrigation in arid areas of the world provides two essential agricultural requirements: (1) a moisture supply for plant growth which also transports essential nutrients; and (2) a flow of water to leach or dilute salts in the soil. Irrigation also benefits croplands through cooling the soil and the atmosphere to create a more favourable environment for plant growth (FAO, 1989).

2.6 Purposes and need for small-scale irrigation in Ethiopia

Faced with a poverty driven depleted resource base, the risk averting strategy that has been followed by the rural community is increasing unsustainable pressure on natural resources leading to land and water depletion and degradation and/or 'forced' migrations to urban areas. In addition, the absence of off-farm income in rural areas has also contributed to the high population pressure on arable land, which leads to fast deterioration of natural resources. This situation will remain a challenge until a high rate of agricultural transformation coupled with maximum and sustainable agricultural productivity (per unit area of land-intensification) takes off from the present crisis. Realizing the present socio-economic situations, it is evident that Ethiopia cannot meet its food security and food self-sufficiency objectives using the prevailing land and water use systems (McCornick et al, 2003).

Improved water management for agriculture has many potential benefits in efforts to reduce vulnerability and improve productivity. Specifically, primary rationales for developing the irrigation sector in Ethiopia include:

- Increased productivity of land and labour, which is especially pertinent given future constraints from population growth
- Reduced reliance on rainfall, thereby mitigating vulnerability to variability in rainfall
- Reduced degradation of natural resources
- Increased exports
- Increased job opportunities, and promotion of a dynamic economy with rural entrepreneurship.

Small-scale irrigation has been chosen by the majority of the cooperating sponsors as a strategic intervention to address food security in Ethiopia. According to (Tom et al, 1999), a number of factors led to this choice. The most obvious of which is that irrigation increases the potential for producing more food more consistently in the drought-prone food-insecure areas. This remains the central theme for these activities and investments.

Agriculture in Ethiopia is dominated by smallholder rain-fed systems but low and erratic rainfall limits productivity and food security. Consequently, investment in small-scale irrigation has been identified as a key poverty reduction strategy. In addition, given the water resources potential, promoting groundwater use and adoption of household level irrigation technologies is crucial. In its Growth and Transformation Plan (GTP), the Government of Ethiopia discusses making use of groundwater by supporting farming households in the adoption and use of private hand-dug wells and suitable water lifting technologies (WLTs). How exactly this can be achieved remains unanswered(Gebregziabher, G., 2008)

2.7 Small-scale irrigation technologies and adoption

Different irrigation systems exist; ranging from intermediate technology systems to manually operated pump systems. Small-scale irrigation technologies are mainly applied in the high potential areas, where farmers have the financial capabilities and know-how and produce market.

Low cost technologies are used by poor small rural households and for home gardening in peri-urban areas. They vary from bucket and drum kit irrigation to rope & washer pump systems, and more advanced treadle pumps and hand operated pressure pumps. Table 1 gives an overview of investment and technical requirements. Some of them are built with locally

available material by local mechanics, and are a distributed locally. Operation and maintenance requirements are low, as are investment loans, but they are labour intensive. However, these systems cannot be applied e.g. in gravity fed communal systems.

Medium-cost technology comprises e.g. motorized pumps, which require less manual labour and can irrigate larger areas in topographical challenging areas.

Beside the small-scale irrigation technologies, community irrigation schemes, mainly with gravity-fed sprinkler or furrow irrigation systems, exist. Communal systems include around 150 to 250 small-scale farmers. Each farmer operates independently and individually and cultivates around 0.2 to 0.4 ha. These systems need more costly and complex irrigation systems and infrastructure, and therefore require loans. Investment costs are around US$ 1500 to 2000 for 0.4ha.

Low-cost irrigation technology is mainly financed through savings and short-term loans, while medium-cost irrigation equipment (e.g. motorized pumps) requires savings in combination with loans.

Another aspect is the varying behaviour of technology adoption of small holder farmers. Not only is African agriculture highly heterogeneous but so are African farmers. Although the differences between large commercial farmers and smallholders in countries such as South Africa and Zimbabwe are evident, what is often less appreciated is the diversity among smallholders themselves. African agriculture is predominantly smallholder, but those smallholders vary tremendously in terms of their access to resources, such as land, market access and the degree to which they are able to produce a marketable surplus (Jayne *et al.,*2006; Jayne *et al.* 2003). Surveys conducted in Ethiopia, Kenya, Mali, Mozambique, Rwanda, Senegal, Somalia, United Republic of Tanzania, Zambia, and Zimbabwe between

the mid-1980s and 2002 found that in no country were more than half of the smallholders net sellers of staples; the modal figure is closer to one third. In Ethiopia only 25 per cent of smallholders were net sellers of either teff or maize, and only 25 per cent were net sellers of maize in Mozambique.

2.8 Farmer Managed Irrigation System (FMIS) changing trends

(Turner, 1994) also described other reasons for the appeal of such schemes to governments and to donors. However, many problems became apparent when these large- scale schemes failed to live up to the expectations, costing far more and producing much lower crop yields than estimated and introducing many new problems while alienating the majority of farmers.
In recent years, there has been an emphasis on the concept of sustainable development, which is often incompatible with increasing river regulation. There is also now a tendency to decentralize management and encourage FMIS by rehabilitating old schemes and handing over control to the farmers involved (Jorma, 1999).

Despite the lack of available statistic, there is no doubt about the importance of small-scale irrigation (SSI) in many developing countries. For many farmers, irrigation is only part of their livelihood but often a very important part. Irrigated fields are usually valued very highly. (Turner, 1994) gave the following reasons for the importance of such FMIS: it can be used to extend the length of the growing season; and as a form of insurance so that when rains start late and upland crops are at risk, crops planted in the valley bottoms or those which receive supplementary irrigation are often the only ones to reach maturity.

Farmers are empowered since they are able to apply water when and where they need it. Capital costs are lower and local labour and skills are employed. In many cases, smallholders can be more productive with their yields and more efficient in water use than larger irrigation schemes (Jorma, 1999).

There is much evidence that farmer-controlled small-scale irrigation has better performance than government-controlled small-scale systems. The substantial farmer-controlled small-scale irrigation sector that exists in many countries in Africa, often without government support, indicates that these systems are economically viable. Areas under farmer-controlled small-scale irrigation systems have grown rapidly over the past decades, and account for large and growing share of irrigated area in Sub Saharan Africa (McCornick et al, 2003).

2.9 Magnitude of small scale and large scale irrigation

Certainly the application of water to plants is irrigation. There could be great differences between countries and agencies over what is meant by "small". In fact, small according to the Indian definition is regarded as large in Africa. (Turner, 1994) points out that irrigation system can be classified according to size, source of water, management style, and degree of water control, source of innovation, landscape niche or type of technology. Most authors, however, agree that concepts of local management and simple technology should be combined with size, and the best working definition seems to be that used by the UK Working group on Small Scale Irrigation (SSI): small scale irrigation is 'Irrigation, usually on small plots, in which farmers have the major controlling influence and using a level of technology which the farmers can effectively operate and maintain'. There is also a case for using the term 'farmer-managed irrigation systems' (FMIS), as used by the International

Irrigation Management Institute (IIMI), which removes the confusion with authority-managed small-scale irrigation.

2.10 Supportive factors for the development of small-scale irrigation includes

- Areas with high agricultural potential (fertile soils, sufficient rainfall, access to financial services)
- Market oriented farmers
- Access to individual short to medium-term loans
- Access to affordable technologies and equipment
- Availability of on-farm water
- Access to markets
- Access to financial services

(GIZ, 2006).

For the most part bypassed by the green revolution and other successful innovations in agriculture production, smallholders live at or below the poverty level and are highly averse to risk; their very livelihoods are focused on keeping the margin for error as small as possible. At the same time, smallholders are capable of managing irrigation systems efficiently provided they have access to affordable technologies that are easy to operate, maintain and repair. Small-scale systems and technologies are attractive since they put the operation, maintenance and management of systems directly in the hands of the individual farmers, thus eliminating any need for centralized control or management (Jorma,1999).

In general, according to (McCornick et al, 2003) all small-scale systems may have advantages over large-scale systems. These advantages include that small-scale technology

can be based on farmers existing knowledge; local technical, managerial and entrepreneurial skills can be used; migration or resettlement of labour is not usually required; planning can be more flexible; social infrastructure requirements are reduced; and external input requirements are lower.

2.11 How to improve livelihoods in irrigated areas?

Improving livelihoods means to strengthen the availability and utilisation of assets and therefore supporting the households to develop strategies that lead to sustainable livelihood outcomes. This can be done by altering given structures and processes.

Human capital: With regard to agricultural water management human capital mainly relates to knowledge and skills of managing the given water resources. In the context of high vulnerability to water scarcity, measures may comprise the introduction of new methods for storing water or new irrigation techniques (or reinventing old ones).

Natural capital: Natural capital refers to all kinds of natural resources that a household needs for production and consumption activities. In the context of agricultural water management, measures aim at securing the access to water and land.

Physical capital: Physical capital means access to all kinds of basic infrastructure as well as tools and technology. Typically investments in irrigation enhance physical capital by building and improving storage facilities, irrigation infrastructure such as intakes, water canals, water catchments etc.

Financial capital: Beside the property of money the term financial capital refers to the access to credits, remittances and governmental subsidies. Financial capital is important for operating and maintaining irrigation systems. Also the investments in new irrigation methods are limited to financial capital.

Social capital: This refers to social resources like formal and informal networks, membership in groups and the access to social institutions. Strong social capital is important in implementing community based approaches (like small-scale irrigation schemes) and can help to absorb financial shocks.

2.12Important elements for access to financial services:

Financial services are rarely available for poor smallholder famers, as most of the financial institutions concentrate on financing input for crop production, lack of experience with small-scale farmers, and products are not adapted to requirements of small-scale farmers. On the other hand, smallholder farmers lack knowledge about financial institutions and available products, and are often biased towards them. However, financial services are available and the financial sector is one of the most developed and diversified in Sub-Saharan Africa. (GIZ, 2006).

These elements include:

- Timely availability, fast processing and costumer friendly
- Flexibility within the product range, especially with regard to repayment mode and collateral requirements,
- The combination of loan products and savings,
- Proximity of financial institutions or delivery mechanisms that allow easy access to financial services. (adapted from: GIZ, 2006).

2.13 Marketing of horticultural produce and related problems

The major constraints of marketing include lack of markets to absorb the production, low price for the products, large number of middlemen in the marketing system, lack of marketing institutions safeguarding farmers' interest and rights over their marketable produces (e.g.

cooperatives), lack of coordination among producers to increase their bargaining power, poor product handling and packaging, imperfect pricing system, lack of transparency in market information system mainly in the export market. Informal transaction prevails in the export system. Producers and local traders receive value for their products only after the exported product is sold. There is a lack of standard for quality control and hence lack of discriminatory pricing system that accounts for quality and grades of the products.(B.Emmana, H.GM, 2007)

Farmers' bargaining power is low due to the lack of alternative market outlet. The most common marketing channel immediately available to the farmer is through brokers. There are up to three brokers between the producer and the trader. Each of the brokers makes a known margin of Birr 5-10 per quintal. The traders/wholesaler and the producer do not have any contact in which case the broker is decisive in setting the price, often making his own margin (unknown to both trader and producer). There is no norm or regulation governing the acts of the brokers and their behaviour negatively affects the farmers.

2.14 Impacts of irrigated production on livelihoods of farmers who participate in HHI

(Adem , 2001) highlighted the positive impacts of enhanced accessibility to water for irrigation. Besides an extended growing period, a higher variety in food and cash crops and, as a result, an increase of cash income thereby food shortages could be reduced. Nearby, the target communities improved the infrastructure of their village and standard of living in general. Negative impacts of the projects were over watering of some fields, overproduction of certain crops and competition for water from nearby communities.

2.15 Objective of Water Users Association (WUA)

Another aspect of Farmer managed Irrigation System is the systematic use of Water Users Associations (WUA). These associations play an important role for sustainable utilization and management of the water resource in addition to the maintenance of harmony in the community.

WUA being the management structure at site (scheme) level and being the owner of the irrigation scheme, it has various objectives, responsibilities and functions in the development process of the schemes. Among the various objectives, the main ones are:

- Coordinate the participation and involvement of the beneficiary communities for equitable irrigation water distribution among the farmers on outlet command basis
- Process and carryout resource mobilization (irrigation O & M fee, labour contribution, material.
- Resolve disputes and conflicts among the beneficiaries that may arise due to improper water utilization.
- Provide support and assistance in the form of labour, cash and construction materials during scheme construction.
- Prepare operations and maintenance plans and ensure their implementation.
- Facilitate irrigation extension, micro-watershed, drainage and pollution control work in the service area or canal network.
- Enlist members and update the list of water user farmers.
- Maintain records
- Propose changes in scheme during planning and construction.
- Prepare and execute irrigation management plans etc.

(Adopted fromthe Project for Capacity Building in Irrigation Development (CBID)May, 2014)

CHAPTER THREE

RESEARCH METHODOLOGY

In this chapter, description of the study area and methodologies are presented. It tries to show how the samples are selected, how the household survey and focus group discussions were conducted and how the collected data/information was encoded and analyzed.

3.1. Description of the study Area

3.1. 1 Location

Wolmera Woreda

Wolmera woreda is located in Finfine zuria special zone of Oromia regional state. Wolmera is found at 38.5° Longitude and 9.07° Latitude and at an altitude of 2520 meters above sea level.**(See the maps on the next pages)**. It has a mean monthly temperature of 16.42 mm and a mean monthly rainfall of 99.25 millimeters. Total area of the woreda is 674 square km. Out of this 19510 hectare of land is suitable for irrigation. The population of the woreda is estimated to be 83,823 and out of this42,115are male and the remaining 41,708 are female. The urban population is 3550 while the rural population is 80,273. The Sex Ratio (SR) is 100.98,the Dependency Ratio (DR)0.92 and the Population Density (PD) 128. (Ethiopian Livelihood Atlas; Wolmera Woreda Office of Agriculture).Administrativelythe woreda is divided into 2 urban and 23 rural kebeles. The administrative center for the woreda is based in Holeta town which is located 42 km to the west of Addis Ababa. Agro ecologically majority of the woreda belong to the Dega and Woina Dega zones. According to the

information from the woreda irrigation authority office the total irrigable land potential of the woreda is 8,845 ha and out of this currently 7,703 ha is cultivated using irrigation. Irrigation is primarily used for production of vegetables.

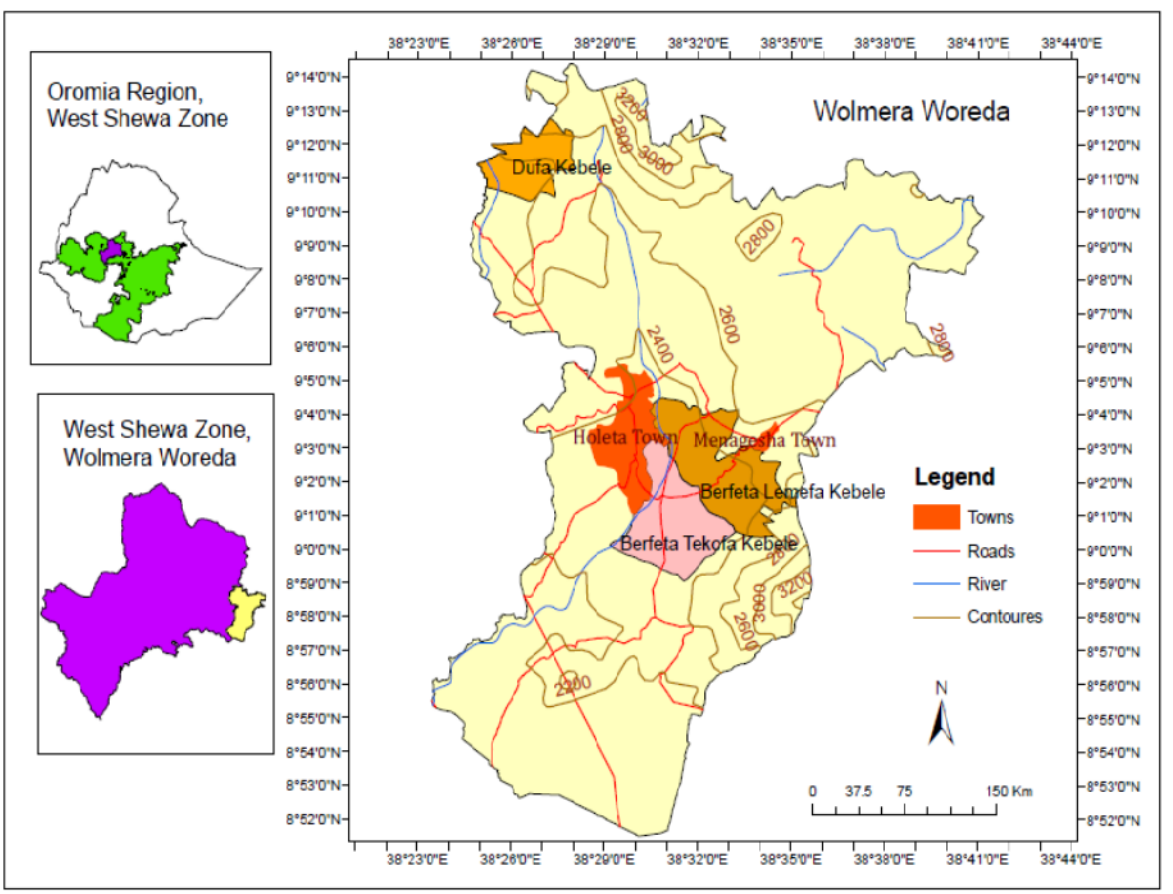

Figure 6. Map of Wolmera Woreda, and location of the study area

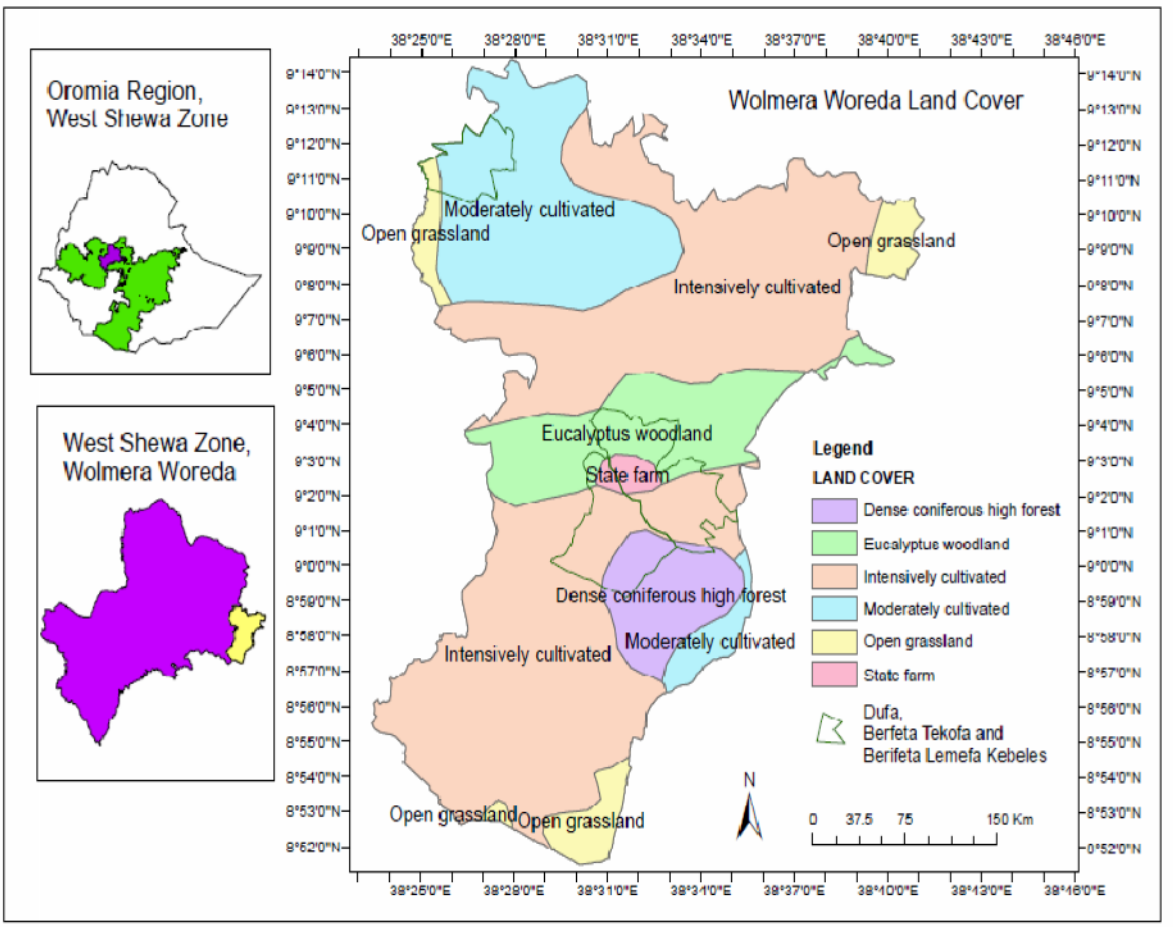

Figure 7: Map of Wolmera Woreda Land Cover

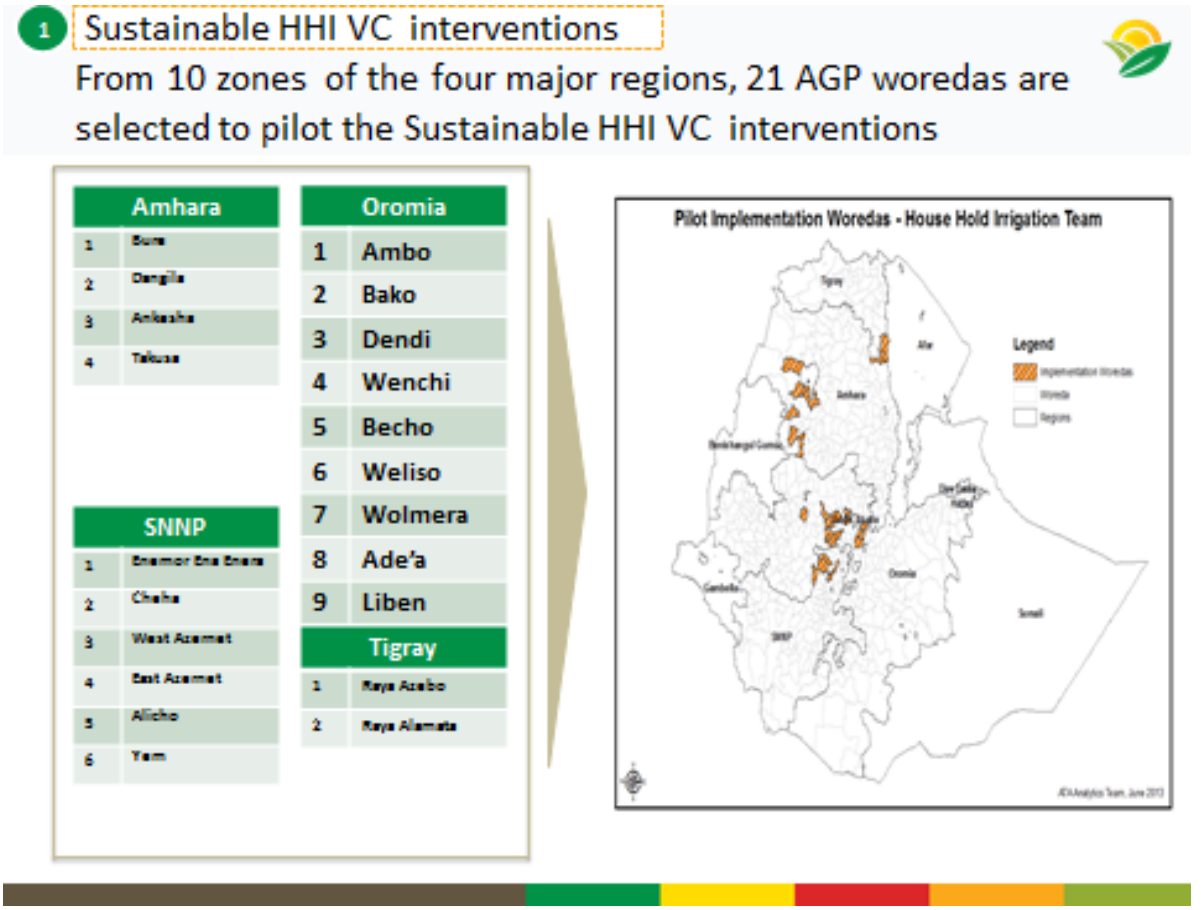

Figure 8: Wolmera, one of the woredas where HHI intervention is being tested

Source: ATA, HHI Strategy document 2013

3.1.2 Agricultural Activities

Crop farming is the main source of livelihood for most of the farmers in the woreda. Wheat, teff, and barley serve as the major cash crop of the woreda. In addition farmers plant eucalyptus as alternative source of cash. Nowadays, potato production is widely practiced as one source of income for smallholders of the woreda.

Because of the efforts made by the research personnel in Holetta Agricultural Research Center, farmers found in the woreda are becoming beneficiaries and have reached to the level

of producing and selling high quality potato seeding material to farmers of the neighboring woredas and their supply has proceeded as far as Tigray and Gondar.

In addition to cereal production, smallholders also practice vegetable and root crop production using rain fed and irrigation agriculture. Most of the farmers in the woreda practice potato production. According to the information from the woreda agriculture office, potato constitute around 65-70% of the area covered under vegetables. The other types of vegetables grown in the woreda include head cabbage, beetroot, carrot, kale, onion and tomato. The information from the woreda irrigation authority office indicates that farmers basically use irrigation mainly to produce these vegetables and root crops.

3.1.3 Socio-Economic Situation

The predominant source of livelihood for the majority of the population is mixed agriculture (crop production and livestock raring). The major crops grown are wheat, barely, and teff from cereals; and potato, onion, cabbage from vegetables. The average land holding per household is 0.5 ha. The major livestock managed in the area include oxen, cows, goats, sheep, donkey, horse, mule, and chicken.

3.2Methodology

3.2.1Sampling, data collection tools and procedures

Random samples of 30 farmers from each of the three kebeles were selected. Care was taken to include farmers who have participated in the use of house hold irrigation technologies. The main tools for data collections were the interview schedule from 90 Farmers, randomly selected from house hold irrigation technology users, Development Agents, Cooperative

Leaders and Woreda Experts. The interview schedules mostly contained close ended questions, though some open ended and structured questions were also administered. A pre-coded questionnaire to collect data from the project staff and Development Agents especially on their opinions on the role of irrigation in agricultural development was also prepared. The questions for the interview schedule were formulated keeping in mind the objectives and research questions of the study. Questions were therefore composed of personal data, family information, work, education, role of irrigation in agriculture etc. Personal observation was also used as a reliable data collection method as information was difficult to obtain by way of interview.

3.2.2 Data processing and analysis

Quantitative raw data collected using questionnaires was organized and pre-processing test was carried out right after the field data collection was completed, and data was arranged categorically. Questionnaires were coded by each kebele to facilitate analysis of questions on which respondents require to specify their opinions and to facilitate analysis of the open-ended questionnaire. Responses on these questions were carefully collected and summarized. Outputs were categorized into different components relating to relevant variables for convenience in the analysis of the findings.

Qualitative data collected through interviews, focus group discussions and observations were put into different categorical variables. Major themes were identified and analysed in line with research questions and were summarized for use in descriptive analysis. Identified themes of the qualitative survey were exposed to categorical arrangements of the quantitative survey outputs. Issues intended to be addressed by the research were analysed using findings from both quantitative and qualitative surveys applying triangulation method. Survey

findings were used to draw arguments on relevant issues and data from secondary sources and to draw conclusions and recommendations.

The completed interview schedule was scrutinized, verified, edited and arranged serially for Coding. Three master code sheets were prepared one for data collected from the households, another for data collected from cooperative leaders, and the third for data collected from the Woreda staff. Data is presented using statistical techniques such as, frequency distributions, tables, pie chart and simple measures of dispersion specifically ranges using percentiles and/or counts. Explanation is provided to clarify information on observed data.

3.2.3 Quality and ethical consideration

The researcher received official permit from Wolmera Special Woreda administration Bureau to conduct this study on Wolmera special Woreda. Wolmera special Woreda Irrigation Development Authority office was willing to assist the researcher. Quantitative survey respondents and qualitative survey informants were provided detail explanation on the overall objective of the study ahead of time. Interview is administered on free will of interviewees. Respondents were informed that they can decline if they don't want to be interviewed. Information provided by interviewees will not be transferred to a third party or will not be used for any other purpose.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter analysis is made to describe the demographic and social characteristics of the respondents, extent of utilization of irrigation technologies, irrigation management practices, extent of extension service provided, change in their livelihood followed by higher production and productivity, the role of cooperatives in sourcing out for improved agricultural inputs, creation of a favorable market linkage that benefits farmers, constraints and challenges in the implementation of irrigated crop production and other parameters

important for addressing the objectives of the study. Thus, the insights offered below should be viewed as indicator results that are meant to stimulate discussion on how use of irrigation technologies can improve rural livelihoods in the study area.

Wolmera Woreda is one of the 21 pilot woredas of the 4 Regions of Ethiopia that have been selected to implement Sustainable House Hold irrigation Value Chain Interventions led byThe Ethiopian Agricultural Transformation Agency (the Agency or ATA) in collaboration with the Ministry of Agriculture and Regional Bureaus of Agriculture that focus on irrigation. The interventions are tested and would be scaled up to the wider Ethiopia based on successful performance.Results of interventions undergoing through the involvement of Agricultural Transformation Agency (ATA) in collaboration with the Ministry of Agriculture are as follows.

4.1 Demographic characteristics of respondents

Table 2:Family composition and Age Structure of House Holds

Age group	Bekeka &Kore Oddo			Dhuffa			Berfete Tokoffa			
Years	Male	Female	Total	Male	Female	Total	Male	Female	Total	Grand Total
Below 5 years	10	12	22	14	10	24	10	6	16	62
5 – 18	32	16	48	58	22	80	34	34	68	196
18 – 65	42	38	80	34	36	70	28	42	70	220
> 65	0	0	0	0	0	0	4	2	6	6
			150			174			160	484

Viewing it in a sex disaggregated manner gives the following

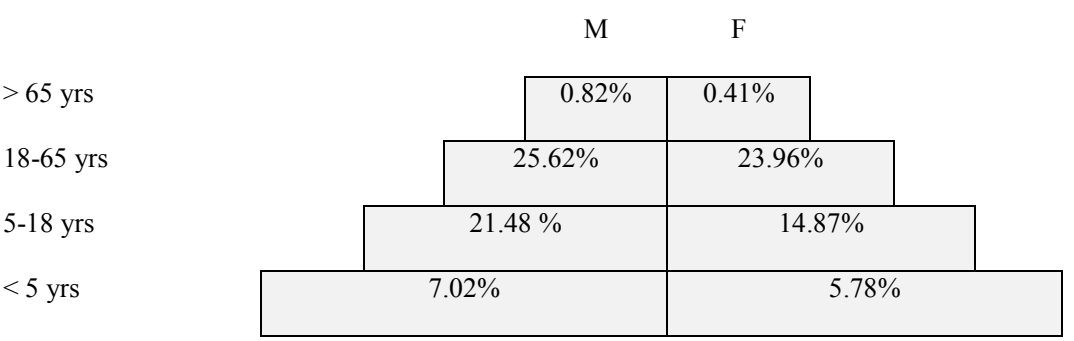

Figure9. Households which practiced HHI Technologies

Age structure of family members of the households for the three Kebeles (Figure 9) indicates that about 47.10% males and 38.83 % females of the family members are in the productive age (18-65 years), indicating availability of labor for practicing household irrigation. Figure 2 shows age structure of the households.

Table 3: Age of house hold heads

Age group	Bekeka &Kore Oddo			Dhuffa			Berfete Tokoffa			
Years	Male	Female	Total	Male	Female	Total	Male	Female	Total	%
15-27	3	1	4	1	1	2	1	1	2	8.8
28-40	1	3	4	11	3	14	9	4	13	34.4
41-52	10	2	12	8	1	9	11	2	13	37.8
> 53	10	0	10	5	0	5	2	0	2	18.8
Total	24	6	30	25	5	30	23	7	30	100

Source: Household survey, Dec, 2015

Eventhough there is no significant difference in the composition of Female Headed House Holds (FHH) between the kebeles, generally we can see that the proportion of FHH is only 20%. This indicates that though the role of women in horticultural production is significant, women are not direct beneficiaries of the fruit of their labor.

Table 4: Marital status, ethnic origin and religion of respondent households

Kebeles	Marital status		Ethnic origin			Religion	
	Married	Single	Oromo	Amhara	Gurage	Christian	Muslim
Berfete Tokoffa	30	0	24	3	3	26	4
Dhuffa	30	0	26	2	2	22	8
Kore Oddo	29	1	28	2	-	18	12
Overall	89	1	78	7	5	66	24

Source: Household survey, Dec, 2015

About 98.8% of the households which practiced HHI are married. Out of the interviewed households, 86.6 % and 7.7% belong to the Oromo and Amhara Nations respectively while 5.7% belong to the Gurage nationality.With regards to the religion of households who are participating in HHI, Christians possess 73.3% while the rest 26.7% are Moslem.(Table 4)shows marital status, ethnic origin and religion of respondent households.

There are no significant differences among the sample respondents of the three kebeles in terms of marital status. Even though the figure is not big, the presence of Gurages (10%) vegetable producers in Berfete Tokoffa and Dhuffa kebeles signifies that they are getting benefit even after paying land rent to land owners. This can also serve as one means of extension to the local community who watch benefits reaped by new entrants.

Table5: Educational level of the HHs

Education Status	Bekeka &Kore Oddo			Dhuffa			Berfete Tokoffa				
	Male Headed	Female Headed	Total	Male Headed	Female Headed	Total	Male Headed	Female Headed	Total	Grand Total	% of Female HHH
Illiterate	12	4	16	7	3	10	6	5	11	37	32.4
Primary	4	2	6	12	2	14	10	2	12	32	18.7
Secondary	8	0	8	6	0	6	7	0	7	21	0
	24	6	30	25	5	30	23	7	30	90	

Source: Household Survey Dec,2015

Education is a crucial factor for skill development and enhancing effective production and marketing decisions. Assessment of educational level of the household heads (Table 5) indicated that about 41.1% were illiterate, 35.55% had primary level education and 23.33% of the households had a secondary Level of education. Out of the total respondents, only 23.3% of the households attained secondary education. And none of the women have a secondary education. This indicates the low level of implementation of improved irrigation technologies. Personal communications discussions and group discussions during the study have shown that those young and educated farmers attain a better quantity and quality of yield than the illiterate farmers.

4.2 Main livelihood activities of the HHs

Cereal crop production was the first main livelihood activity for 35.5% of the households, livestock rearing was the second source of income for 34.4% of the Households, vegetable production was the third source of income for 14.4%, and the rest 15.7% depend on Honey Bee

keeping, wage labour and petty trade before practicing House Hold Irrigation.(Table 6) shows the percent of households which practiced HHI with different types of economic activities ranked from 1 to 6 main livelihood options. Given that livestock production is the second main livelihood activity for majority of the households, integrating forage/bee fodder development with HHI can have further contribution in transforming small-holder farmers.This scenario is changing as the house holds begin to practice irrigated vegetable production. Accordingly, the % change of source of livelihood has changed in magnitude towards irrigated vegetable production by 161%. The dependence on cereal crop production as the primary source of livelihood has declined by 6.25% and that of livestock by 48.4% and wage labor by 85.7% and some sort of diversification is also observed.

Table 6: HHs engaged in different economic activities as their 1st and 2nd and third livelihood options down the sequence

		Bekeka &Kore Oddo			Dhuffa			Berfete Tokoffa			Overall %change
No	Livelihood	BHHI	AHHI	% change	BHHI	AHHI	% Change	BHHI	AHHI	% change	
1	CerealCrop production	9	8	-11.1	10	12	20	13	10	-23	-6.25
2	Livestock production	11	7	-36.6	13	6	-53.8	7	3	-57	-48.4
3	Vegetable production	4	12	200	3	8	166	6	14	133	161
4	Honey bee	2	3	50	1	3	200	1	0	-100	50

	keeping										
5	Wage labor	3	0	-33	2	0	0	2	1	-50	-85.7
6	Petty trade	1	0	-100	1	1	0	1	2	100	0

Source: Household survey, Dec, 2015

The respondents depend on different means of income generation strategies. Previously, cereal crop production was the major source of income followed by livestock rearing for the majority of the producers. But currently, after the introduction of House Hold Irrigation as a program, the role of cereal crop production and livestock rearing has declined by 6.25 and 48.4 % respectively. The role of vegetable production has surprisingly increased more than double due to the potential to harvest at least twice in a single season and the potential of increased productivity from a small plot.

Table 7: Change in livestock size of households as a result of engagement in irrigated production

No	Items	Before Joining HHI				After Joining HHI				Difference	% change
		BKO	Dhufa	BTok	Total	BKO	Dhufa	BTok	Total		
1	Cattle	130	68	96	294	219	104	142	465	171	58.16
2	Shoats(sheep &goats)	121	95	89	305	231	169	168	568	263	86.23
3	Equines	30	57	10	97	48	92	27	167	70	72.16
4	Chicken	73	73	62	208	182	182	229	593	385	185.10
5	Bee Hives	82	34	34	150	147	139	84	370	220	146.67

Source: Household survey, Dec, 2015

Irrigation gives lots of opportunities for farmersif they properly utilizethe potential in their surroundings. As it is indicated in **(Table 7**the quantity of all kinds of livestock has increased significantly after households begin implementing irrigated crop production using improved technologies. The percentage change for cattle, shoats, equines, chicken and Honey bee was 58.16 %, 86.23%,72.16%,146.67% and185.10% respectively.

Especially integrating irrigated vegetable and fruit production with livestock rearing would be complementary as livestock can get additional forage and pasture from the irrigation and also by products of vegetables and fruits.

Table 8: Types and number of Water sources and lifting mechanisms that Households which practiced HHI used

	Water source	Lifting mechanism	
kebeles	River	Rope &Washer	Motor
Berfete Tokoffa	28	2	-
Dhuffa	27	3	-
Kore Oddo	25	2	3
Total	80	7	3
%	88.8	7.7	3.3

Source: Household survey, Dec, 2015

The main resource for irrigation is availability of water that can be used for irrigation. At this stage it might be difficult to decide and prohibit certain water resources in the midst of all the efforts to instill the concept of irrigation. There should also be lifting mechanisms where it would be difficult to use the water by gravitational system. (Table 8) tries to show the Types and number of Water sources and lifting mechanisms that Households which practiced HHI used. Accordingly, 88.8 % of the households in the three kebeles used river water diverted fromKocha, Boobe and Dhuffarivers. Only 7.7% of the households engaged in HHI use manually operated irrigation pumps and 3.3 % use motor pumps to lift water from different sources.

4.3 On-Farm production

Repeated trainings have enabled participating farmers to have a better knowledge on irrigation needs that are balanced against the sustainable use of water resources. Extension services are destined to fully support farmers in irrigated agriculture. Farmers try to adopt best practices in irrigation agriculture for their local area. Seed bed preparation, seedling management,transplanting, Irrigation water management, crop protection, harvesting and post harvesting technics have been provided through theoretical and practical trainings to farmers of the kebeles.

Table 9:**The numbers of times per year farmers grow crops and/or vegetables using irrigation**

Kebele	NumberBefore joining HHI			Number After joining HHI		
	Once	Twice	Thrice	Once	Twice	Thrice
Berfete Tokoffa	17	13	-	56.6	43.4	-
Duffa	10	20	-	33.3	66.6	-
Kore Oddo	6	22	2	20.0	66.6	6.6
Total	33	55	2			

Source: Household survey, Dec, 2015

One of the merits of irrigation is maximizing produce by producing more than once. (Table 9) shows that out of the sample households, 36.6 % produce only once per year before joining HHI. On the contrary, after joining HHI program,nearly 58.8 % of the sample households produce twice a year and a few farmers produce three times a year by selecting HVCs and following an appropriate cropping calendar

Table 10:**Number of Households who use HVC selection tool and cropping calendar**

	Before joining HHI(2013)		After joining HHI (2014)	
Kebele of HH	**Number**	**Percent**	**Number**	**Percent**
Berfete Tokoffa	10	33.3	15	50
Duffa	7	23.3	11	57
Kore Oddo	14	46.6	24	71.4
Total	31		50	

Source: Household survey, Dec, 2015

One of the improvements in carrying out horticultural production is the selection of the appropriate high value crops followed by cropping calendar. These trainings had been provided to all farmers found in the woreda through the initiative of MoANR and ATA. As a result the percentage of farmers who have used HVC and cropping calendar on the average increased from 34.4% to 59%.(Table 10)

Group discussions carried out with the HHI participants of the villages has shown that the major vegetable production constraints are problem of getting high quality inputs with reasonable price and at the right time, lack of extension support services, lack of storage facilities for their produce which are perishable, lack of spare parts and maintenanceservices for their irrigation technologies and finally problem of getting an honest buyer.

Table 11: Types and quantities of inputs used by the sample households in 2013 and 2014 crop production seasons.

No	Types of inputs used For irrigated production	2005	2006		
		Before Joining HHI	After Joining HHI	Difference	% Change
1	Improved seeds (kilogram)	372	691	319	85
2	Fertilizer (kilogram)	83	152	69	83
3	Agrochemicals (liters)	57	98	41	72

Source: Household survey, Dec, 2015

Irrigation being a capital intensive endeavor, households require an additional amount of resource to attain increased production and productivity. As expressed in (Table 11), farmers have realized and have committed their resources for improved seeds, fertilizers and agrochemicals. Most of all, farmers have understood the benefits that would accrue through using improved inputs and production systems and do not hesitate to implement extension advisory services. Within a one year time, the % change in utilization of inputs has exhibited 85, 83 and 72 percent for improved seeds, fertilizers and agrochemicals respectively. The use of postharvest technologies, especially DLS (Diffused Light Storage) for potatoes is being constructed in a few model farmers' compounds.

Table 12:Changes in total production and productivity in terms of yieldas a result of the aforementioned interventions, amount consumed and sold out to consumers.

S/N	Sample HH Producing crops	Unit	Before Joining HHI (2013)			After Joining HHI (2014)				
			Average production per year	Consumed at home	Mark-eted	Average production per year	Consu-med at home	Market	Differ-ence in production	% Chan-ge
1	Bek / Kore Oddo	Tons	104.7	74.2	30.5	204.6	109.6	95.0	999	95.4
2	Dhuffa	Tons	63.4	18.6	44.8	170.4	78.3	92.1	1070	62.8
3	Berfete Tokoffa	Tons	50.8	36.9	13.9	118.6	84.5	34.1	678	57.17
	Total	Tons	218.9	129.7	89.2	493.6	272.4	221.2	274.7	

Source: Household survey, Dec, 2015

(Table 12) tries to show the changes in total production and productivity in terms of yield, amount consumed and sold out to consumers as a result of the aforementioned interventions, and compares it with the previous scenario before joining the HHI program.

Table 13: Farmers who have participated in HHI have become key saving account users.

	Before joining HHI (2013)		**After joining HHI (2014)**
Kebele of HH	**Amount in USD**		**Amount in USD**
Berfete Tokoffa	500		8723
Duffa	100	3571	
Kore Oddo	1176	7119	
Total	**1776**		**19413**

Source: Household survey, Dec, 2015

Most of our farmers do not have a culture of saving money in banks. They rather engage in informal saving and social security associations. Participating in HHI has brought up larger transactions that commence with purchases of inputs, payments of fees, costs of wage, storage, transportation and hence frequent withdrawal and deposition of money is realized thereby initiating additional savings. (Table 13) shows the change that occurred after the introduction of interventions.

Table 14: Agreeing or disagreeing whether family life style changed especially in terms of nutrition, child education and increased income due to joining HHI.

Kebele	**Frequency and percentage of respondent HHs**				
Berfete Tokoffa	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Number	6	18	2	4	0
%*	(35.3)	(36)	(16.6)	(40)*	
Duffa					
Number	3	12	8	6	1
%	(17.6)	(24)	(66.8)	(60)	(100)
Kore Oddo					
Number	8	20	2	-	-
%	(47.1)	(40)	(16.6)		
Total	17	50	12	10	1

* Percentages only add up downwards

Source: Household survey, Dec, 2015

(Table 14) shows the level of awareness that respondent households have arrived at. Out of all respondents, 47.1 % of Kore Oddo have strongly agreed that joining HHI and using improved inputs have brought a significant change on their livelihood within this short period

of time. Similarly, 40% of them also agree. 16.6 % have a reservation and selected neutral. Farmers of this kebele are so motivated, and work to a maximum of three cycles of cropping per year. Households of Dhuffa farm as large as 66.6% showed a neutral stance and this needs further investigation. One of the probable reasons might be the breaching of the marketing contractual agreement signed between producer cooperatives and Etfruit.

4.4 Research Knowledge and policy

The research system advances science in all aspects of the irrigated agriculture value chain.Farmers understand the location and best usage of water resources.Farmers have attained better knowledge on the interrelationship between irrigated production, market demand, price fluctuation, sorting, grading and value of quality products. Subject matter specialists and Development Agents have the responsibility in guiding farmers how to use improved research outputs and on-farm production activities through trainings, field demonstrations and face to face information exchange. In this respect the level of extension service provision and thereby adaptability to use of improved inputs, irrigation water management, crop protection and post-harvesting have been assessed and the result is displayed in the following table.

This has been realised through the High Value Crop Selection Tool that was prepared by ATA. Experts have been trained on the utilization of the tool. After the HVC are selected, cropping calendar would be prepared by experts and farmers are guided to follow up with the cropping calendars.

4.5 Training at different levels

Table 15:**Acquisition of training on irrigated vegetable production and topics of training**

Kebele	Have you taken training?		Topics of training			
	Yes	No	Production	Post harvest	Marketing	All
Berfete Tokoffa	28	2	3	5	10	12
Duffa	26	4	15	4	6	5
Kore Oddo	29	1	3	2	2	23
Total	83	7	21	11	18	40

Source: Household Survey Dec, 2015

Generally speaking our farmers are risk avoiders. They take longer time to enter into a new venture, adopt an improved technology and adopt a proven technic even though it has been demonstrated in Farmer's Training Centres (FTCs) or fields of model farmers. This can be improved through repeated trials and extensive trainings supported by practical sessions. (Table 15) shows that 92% have taken training and out of this 44.4 % have covered all the topics that were provided on vegetable production, crop protection, postharvest handling and marketing of produce which is preceded by sorting and grading followed by storage.

In addition to this the Free Dial Interactive Voice Record system (IVR) through **8028** initiated by ATA has helped Subject Matter Specialists, Development Agents and farmers get access to a pre-recorded content on irrigated vegetable crop production at any time and anywhere a mobile phone operates. A snap shot of the contents are displayed in each kebele of the pilot woredas. The utilization level is also increasing from time to time.

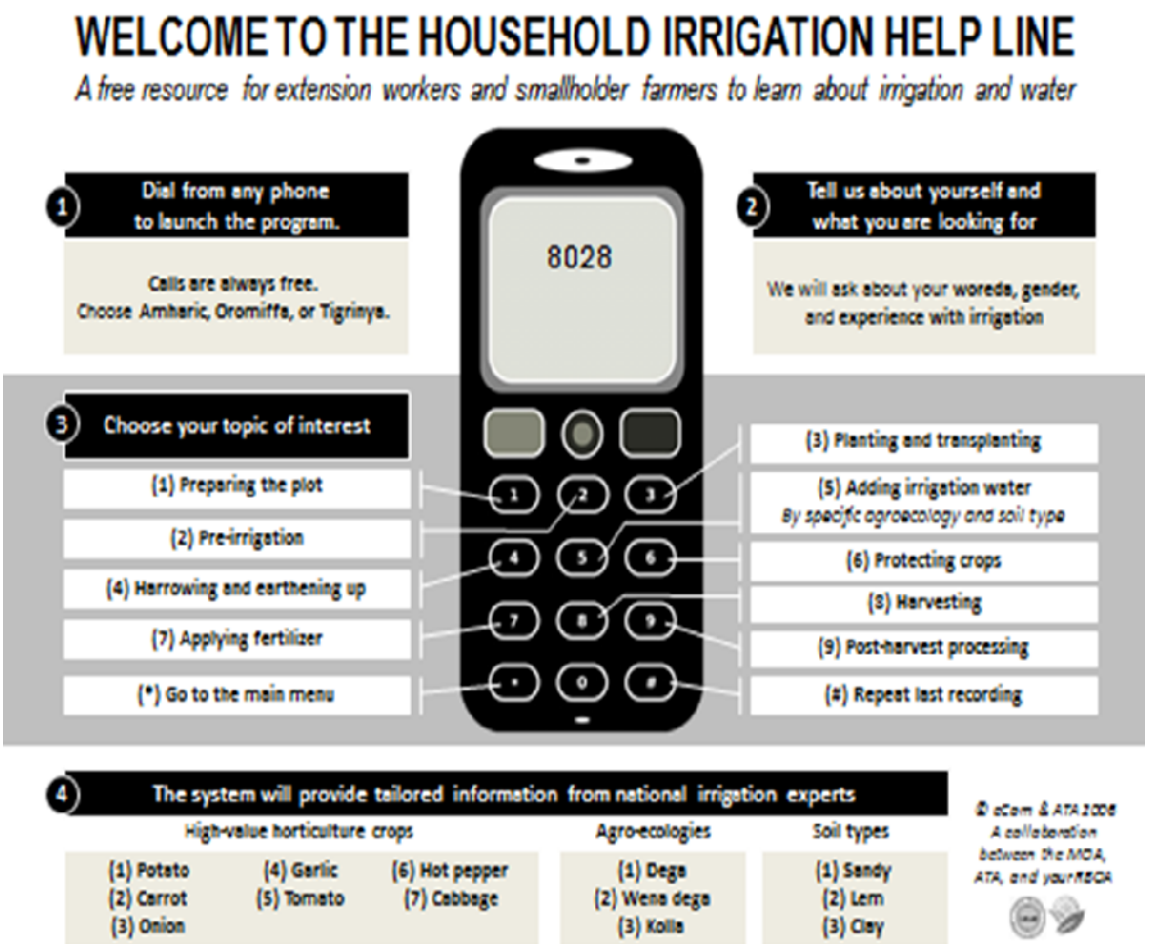

Figure 10: Household Irrigation Extension Helpline **8028**

Source: HHI and ICT Teams, ATA

Response of respondents on their utilization level of IVR

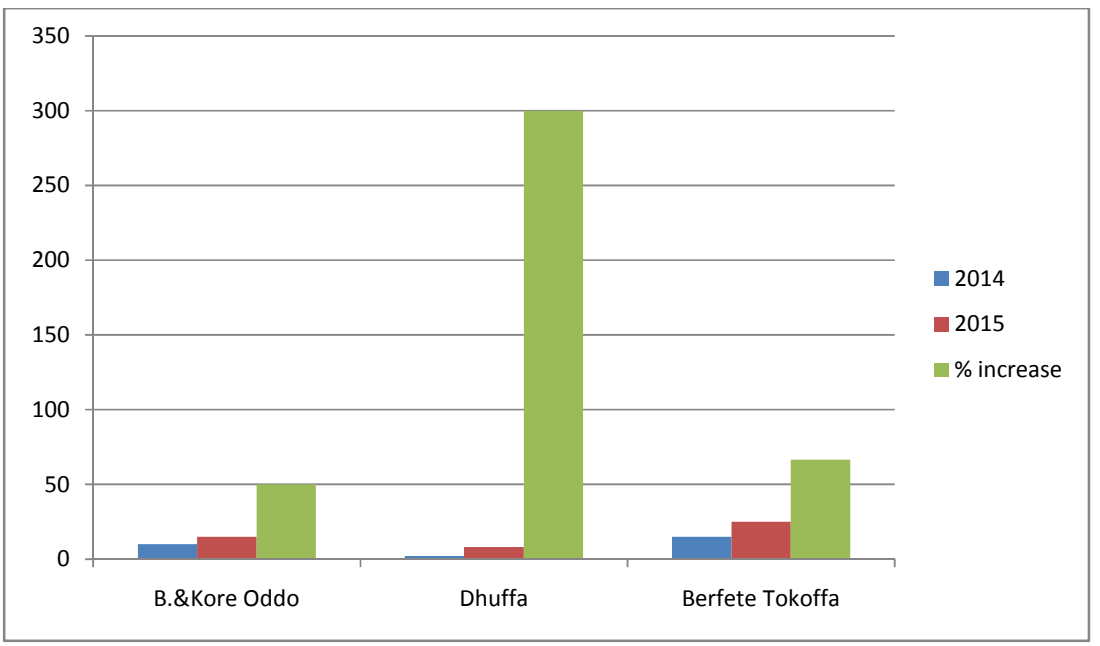

Figure 11: Number of users of the 8028 free dial extension support

The number of users is increasing from time to time and that of women is much significant as obtained from group discussions.

4.6 Availability of Financial Credit and utilization level of HH

Production under irrigation requires additional tools, equipment, skilled labour, capital, warehouse, spare parts and maintenance services. For these purposes, the farmer requires financial source to immediately secure the money and undertake the procurement and continue operation.

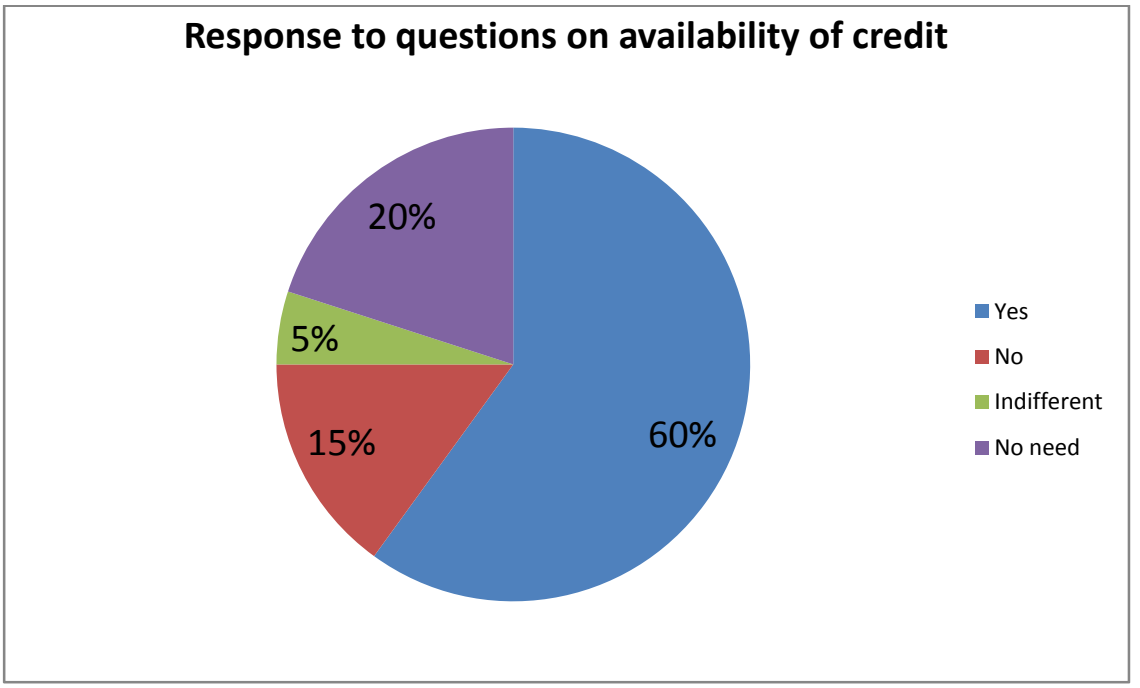

Figure 10: Response on availability of credit

As can be demonstrated from the figure, there is access to credit. The farmers are also cognizant of it. But the farmers do not dare to take credit and no substantial reason could be extracted from their argument through group discussion. An informal one-to-one discussion revealed that they are not in a state of confidence to sacrifice their meagre resources that may be damaged by lack of water, pest attack or lack of a reasonable sales price.

4.7 Improved Agricultural Inputs

One of the major challenges of irrigated crop production is lack of dependable sources of improved, high quality agricultural inputs. On top of this, the price charged for better quality seeds and pesticides discourages farmers from using these inputs. The other is the timeliness of provision of the inputs. Though Wolmera woreda is nearer to the central market at Addis Ababa, farmers are still facing all the problems mentioned above.

4.8 Irrigation Technologies

Through the interventions, farmers are able to access and afford household irrigation technologies such as improved seeds, fertilizers, farm equipment, agrochemicals, improved produce storage, awareness on quality, access tospare parts and maintenance services for irrigation pumps.

4.9 Extension contact

The survey results showed that the majority of the onion growers (82%) had extension activities whereas (17.5%) of the respondents do not receive extension service (Table 16).

Table 16: Farmers access to Extension service in all the three kebeles

Response	Number of respondents	Percent
Yes	33	82.5
No	7	17.5
Total	40	100.0

Source: Household Survey, December 2015

Table 17. Response on the level of Subject Matter Specialistsupport to farmers

Description	Strong	Weak	%
Extension	2	1	66.6
Vegetable production	3	0	100
Postharvest handling	2	1	66.6
Product quality	2	1	66.6

Source: Household survey, December 2015

Out of the 3 woreda experts interviewed, only support on vegetable production was fully provided, while the support for the rest such as for extension, product quality and postharvest handling were only 66.6%.

Table 18: Response on the level of Development Agent support to farmers in the 3 Kebeles

Description	Strong	Weak	Not reached	Percentage of strong
Irrigation water management	4	1	1	66.6
Crop protection/spraying	3	1	2	50
Postharvest handling	4	2	0	66.6
Pump maintenance	2	3	1	33.3
Market linkage	4	2	0	66.6

Source: Household survey, December 2015

Result from the interview on Support of Development Agents to farmers on Irrigation water management, Market linkage and Postharvest handling looks strong (66.6%) but this does not correlate with the response of farmers on acquiring trainings on the specific topics mentioned above. Hence, this requires a specified investigation to be made further.

Table 19: Response on the level of Cooperative Leaders' support to farmers

Description	Strong	Weak	% of strong support
Input provision	4	1	80
Irrigation Water distribution	2	3	40
Credit facilitation	3	2	60
Market linkage	4	1	80

Source: Household survey, December 2015

Out of the interviewed 5 Farmers' Cooperative Leaders, the feedback accordingly is that 80% of the support is for input provision and market linkage of farmers to buyers while credit facilitation and irrigation water distribution support are 60 and 40 % respectively.

4.10 Post-harvest handling

Horticultural products are perishable by nature and need special care all the way through harvesting, sorting, storage and transportation. Farmers of the woreda also face same sets of challenges in postharvest handling of horticultural products. Due to targeted interventions and extension work on this there is progress especially in constructing Diffused Light Storage systems with joint technology promotion of Holetta Agricultural Research Center, MOA, and ATA.

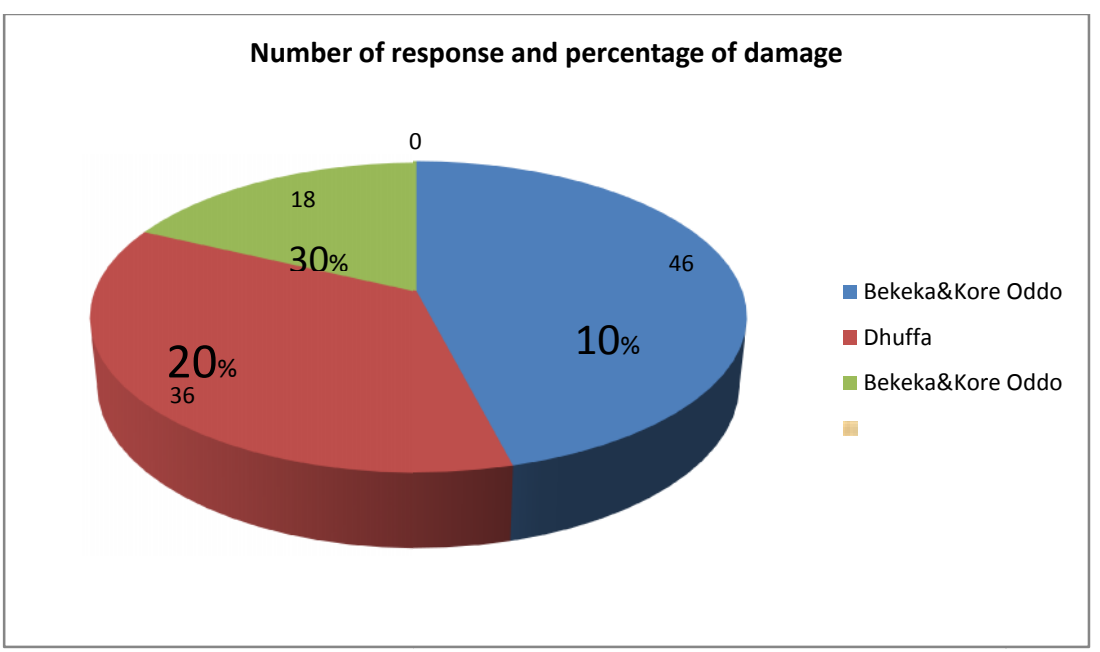

Figure13: Damage level of produce due to lack of storage

(Figure 13) depicts the response obtained from house hold respondents on the level of damage that they face after harvest due to lack of proper storage and handling. 46, 36 and 18

respondents of the three kebeles expressed their feeling that 10%, 20% and 30% of their horticultural produce is damaged by lack of storage.

4.11 Market Linkage

The other decisive component of the value chain is marketing of farm products. Farmers face challenges in finding an appropriate buyer and a favourable and stable price for their products. But the existing situation is under the control of middlemen who contribute nothing but at times gain higher than both the producer and the buyer. The ATA had taken the initiative to bring together HVC producers and ETFRUIT (A parastatal company) that is fully mandated to buy, process, pack and sell vegetables and fruits to local and international markets.Both parties had entered into contract to transact about 200,000 MT of vegetables in 2014/15 season. Unfortunately, both parties did not respect the terms of the contract and could not continue with it.

In a group discussion, farmers of the villages responded that after different capacity building trainings were provided on marketing and market linkage, newer market channels for high-value crops have given farmers' maximum return on yield.Farmer's exposure to price fluctuations is minimizedand new markets are opened for increased production too.

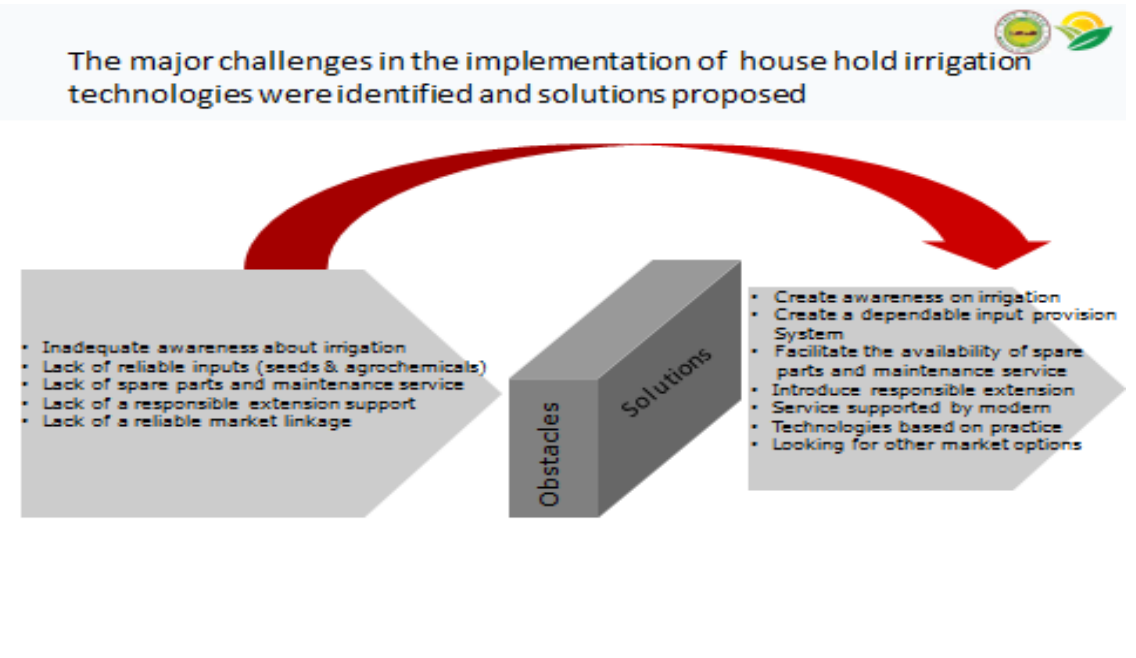

Figure 14: obstacles and solutions in HHI intervention

Source: Survey outcome

Summary of results

The objective of this study was to assess the effectiveness of improved technologies in transforming the lives of small holder farmers. Accordingly, a hugecapacity building task has been carried out through trainings at Farmer's Training Centers (FTCs), field demonstrations, exposure visits in best performing farmer's fields within and outside the woredas. The topics of training were Vegetable crop production and protection, irrigation water use and postharvest handling. The provision of 8028 Toll Free Interactive Voice Record (IVR) system has enabled Experts, Development Agents (DAs) and farmers; especially women in availing extension advice at anytime and anywhere from a prerecorded content prepared by senior experts from Ministry of Agriculture(MOA), Ethiopian Institute of Agricultural Research (EIAR) and Ethiopian Agricultural Transformation Agency(ATA).Provision of

improved agricultural inputs had been a problem and may continue so for long unless the sector designs different mechanisms for a sustainable and accountable service provider.

The other important achievement is enabling farming households produce High Value Crops (HVCs) initially by selecting the crops using a tool prepared by ATA. Farmers are guided by experts to arrive at an economically feasible crop after each candidate crop is tested against 21 variables based on the locality. A cropping calendar is prepared for those 2-5 crop and variety options that match with the market demand of the surrounding.

Farmers have also become beneficiaries of locally manufactured manual irrigation pumps and engine pump maintenance services from technicians who were trained in Agricultural Mechanization Research Center at Bako with support from ATA.

Due to the perishability of vegetable crops, farmers face challenge in postharvest handling. At times, they become victims to the fraud of middlemen by selling far lower than the actual market price knowing that they cannot store longer. This drives to lack of confidence on the side of farmer to produce sustainably. Recognizing this fact, MOA and ATA had jointly facilitated a contractual agreement between Farmers' Cooperatives and a parastatal organization; Ethiopian Fruit and Vegetable Marketing Enterprise; locally named Etfruit and lately additional institutional buyers such as Universities, Hospitals and other larger organizations. Wolmera woreda being one of the 21 pilot woredas for testing House Hold Irigation improvement interventions, the farmers in the 3 kebeles were represented by their union and benefited a lot though there were problems in respecting the terms of the contractual agreement and interference of the middle men.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This chapter consists of the conclusions drawn from the result and discussion part of this study and the implication of the findings. Recommendations are provided for interventions that enhance the efficiency of agricultural cooperative in increasing their role in the whole livelihood improvement of the local community.

5.1. Conclusion

This research discovered the prevalence of direct link between smallholder commercialization and agricultural productivity as the former plays a significant role in improving the latter one. This implies that any policy effort aimed on creating efficient tie between farmers and market will improve the performance of agricultural production particularly in a situation where financial and credit constraints widely prevail. Thus, increasing farmer's educational level, creating sufficient access of ICT tools including radio and cell phone significantly contributes for higher degree of market participation.

One of the key finding regarding causality between farmers level of productivity and commercialization is that productivity becomes a function of commercialization in a significant manner. In fact, this finding coincided with the argument forwarded by Gebre-ab (2006) stating minimal influence of agricultural productivity on market participation in subsistence agriculture where farm households still supply certain proportion of output from their basic subsistence level. This is possibly associated with lack of diversified livelihood in rural Ethiopia where farmers largely rely on subsistence agriculture.

Even though farmers in the study area reside at only 40 kms from the capital city of the country, they similarly face problem in marketing their produce. The linkage established with Etfruit and other institutional buyers has helped them to be aware of sorting and grading, product quality, storing, price negotiation and producing based on market demand.

Hence, participating in House Hold Irrigation Program has definitely shown a significant difference between farmers themselves while comparing the scenario before their entry and also when comparing them with other farmers who have not joined the HHI program.

The results reveal that the households participating in irrigation use both traditional and modem methods of irrigation. A variety of crops are grown on the irrigated farms, the dominant ones being maize, beans, cotton and vegetables. The impact of irrigation on household welfare was assessed using quantitative and qualitative data with respect to employment, income, production and consumption. The results reveal that members of households are variously involved in irrigation activities such as ploughing, planting, weeding, harvesting and watering.

The responses given showed that during the 2013 - 2015 period, there was a general increase in the amount of agricultural production under irrigation. The households also earned income from the sale of their irrigated crops. Majority of the respondents earned up to Ethiopian Birr 10,000 each in 2014 and 2015 without considering the consumption at home and the reserve for seed.The money earned was used essentially to satisfy the basic and domestic needs of the households as well as attend to some needs of the community, In their qualitative statements on the benefits received from irrigation, the respondents indicated two main benefits: increase in production and improvement of the general welfare of the households in health, shelter, education and food.

Consequently, improved income has a potential of progressing the wellbeing of households in terms of food security, assuming other factors constant. Particularly, commercialization is supposed to bring a large impact on increasing farmer's income level which can be used as a source of fund for food purchase with better quality and quantity. However, other exogenous factors including price changes may reduce the consumption bundle of framers in a situation of price shock.

5.2. Recommendations

On-Farm production

Time has come that strengthening a meaningful extension service that is palatable for the taste of the farmers is mandatory. There are signals that farmers' acquisition of extension service is significantly decreasing. On one side, the Development Agents do not regularly avail their service to the farmers because of several reasons such as engagements in input distribution, loan repayment follow up and other political commitments and on the other side farmers have become less eager to ask for extension advice from Development Agents.

- The availability of toll free 8028 IVR (Interactive Voice Record) system has enabled farmers to get information in Amharic, Oromiffa and Tigrigna languages on irrigated vegetable production, crop protection, irrigation water management and postharvest handling technologies.
- In addition to this an SMS problem solving extension service is at its' piloting stage in 16 woredas of the country.
- A third alternative also under piloting stage is a video based demonstration of farm operations directly filmed on farmers' sites with the direct involvement of farmers. These films are displayed on any white surface in any place for groups that consist of 15-20 persons using a Picho projector, which is not bigger than an iPad.

- Designing of a Farmers' Service Centre (FSC) that is responsible for the provision of improved agricultural inputs has been initiated by ATA and found to be feasible in pilot woredas and would be highly recommended to be scaled up to a vast area based on best performance.

Technology adoption

- Support the establishment of businesses that sell a variety of pumps and provide after-sales services and parts. Businesses that cover the entire chain, including the sale of farm produce, may overcome the problems that farmers face with market traders. This will increase profit and make the whole business more sustainable.
- Provide support in terms of start-up capital, tax exemptions etc. (but try to select options that will benefit the poor).
- Train dealers in technical aspects, marketing and after-sales services, and support them in setting up demonstration plots.
- Strengthen extension services to provide guidance on Water Lifting Technologies and irrigated agriculture and incorporate experience sharing tours.
- Develop pump maintenance and repair manuals in local language.
- Explore credit arrangements and supportive policies that enable farmers to purchase WLTs without collateral or proof of future income.
- Explore opportunities for pump rental markets.
- Develop and air appropriate informational programs on the radio.

Improving marketing of horticultural products

As it has been mentioned earlier, irrigated agriculture is so expensive that farmers do not dare to commit their meager resources unless they are certain that they obtain a dependable return. Even though it takes time to convince farmers to use improved agricultural technologies, they will definitely cope up through demonstrations on common field sites or model farmers' fields. What they cannot change is the market aspect. However, this is a cumulative effect and getting a reasonable return from a fair market is their wish for a sustainable engagement in the operation. Prices of horticultural crops are volatile and most of all the havoc that the middlemen create is so important that all concerned should create an amicable solution to protect the interest of the farming community.

The market improvements revolve around institutional, legal frames, education, developing market facilities. The following concrete recommendations will improve the marketing system and enable fair and equitable distribution of the welfare generated from the marketing system:

· Establish and enforce a legal system in the marketing management. Defining quality parameters, standards, grades and putting regulatory frameworks to enforce pricing based on standards is important. The "Wesla" measurement system should be replaced by scientific units such as weighting on a standard balance. In this connection, the negotiation capacity/skill of the producers should be developed.

· Legalize the functioning of brokers in such a way that they will be accountable for their practices and enforce true functioning of a competitive marketing system;

- Organize (voluntarily) traders and producers and establish trustful and strong trade agreements between the two institutions. Attempts to organize the traders and producers without establishing a linkage between the two have resulted in rival relationships between them. Neither the traders nor the producers succeeded. There is a strong need to organize them as business associations and build their business management capacities to operate as partners rather than rivals.

- Improvement of the market information delivery system in this process is necessary. With a strong relationship between traders and producers, searching for market information and dissemination will be crucial.

- Undertake research to support producers and traders with postharvest storage technologies.

- Build the marketing extension capacity in terms of institutions and human resources.

References

Abebaw, Shimeles. 2003. Dimensions and determinants of food security among rural households in Dire Dawa, Eastern Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University. 152p.

AboneshT., Ayalneh B., Regassa E. Namara.(2006)The Impact of Small Scale Irrigation on Household Food Security: The Case of Filtino and Godino Irrigation Schemes in Ada Liben District, East Shoa, EthiopiaMinistry of Water Resources, Haramaya University, IWMI-Acra

Adem F. Small-Scale Irrigation and Household Food Security. A case study from Central Ethiopia. FSS Discussion Paper No. 4; Forum for Social Studies, Addis Ababa, February 2001.

African Development Bank, FAO, IFAD, IWMI, World Bank, 2007. *Investment in agriculturalwater for poverty reduction and economic growth in Sub-Saharan Africa*, WashingtonD.C.: The World Bank.

AGP Baseline Survey (2012), conducted in 2011-2012 in AGP and non-AGP woredas.

Alemneh Dejene (2003): Integrated national resources management to enhance food Security: the cause of community based approaches in Ethiopia. FAO, Rome, Italy

Awulachew, B., Merrey, J., Kamara, B., Van Koppen, B., Penning de Vries, F., and Boelee, E. 2005. Experiences and opportunities for promoting small scale micro irrigation and rain water harvesting for food security in Ethiopia. Working paper 98.

Awulachew, S B; T Erkossa; R E Namara (2010). Irrigation potential in Ethiopia, Constraints and opportunities for enhancing the system. Colombo, Sri Lanka: International Water Management Institute (IWMI)

Barry, Boubacar; Namara, Regassa E.; Bahri, Akissa. 2009. Better rural livelihoods through improved irrigation management: Office du Niger (Mali).

Bastiaanssen W.G.M. and Bos M.G. 1999. *Irrigation Performance indicatorsbased on remotely sensed data: a review of literature.* Irrigation andDrainage Systems, 13: 291-311.

Bernard, T., E. Gebremedhin, and A.S. Taffesse. (2007), Smallholders' commercialization through cooperatives: A diagnostic for Ethiopia. IFPRI discussion paper no. 00722. Washington, DC: IFPRI.

Carney D. (1998). Sustainable Rural Livelihoods: What contribution can we make? London:DFID.

Chamber, R. 1994. Irrigation against Rural Poverty. pp. 32-33. In Socio- Economic Dimension and Irrigation, ed., R.K. Gujar. Jaipur. India: Printwell.

CSA (Central Statistical Authority). (2003), Ethiopian Agricultural Sample Enumeration (2001/02 (1994 E.C.)) – Results at the Country Level. Addis Ababa: CSA.

Department for International Development (DFID), 2005. Growth and poverty reduction:

The role of agriculture. *DFID Policy Paper*, London: DFID.

EARO (Ethiopian Agricultural Research Organization), 2002. *Concept Paper onAgricultural Water Management*. Addis Abeba, Ethiopia.(*Unpublished*) 15pp.

Emana, B., and Gebremedhin, H., Drylands Coordination Group Report No. 46 (02, 2007) c/o Miljøhuset G9 Grensen 9b N-0159 Oslo Norway

Ethiopian Livelihood Atlas 2011

FAO (Food and Agricultural Organization of the United Nations).2005. Global information and early warning system on food and agriculture. World food program. Special report. Italy, Rome.

FAO (Food and Agricultural Organization of the United Nations), 2001. The state of food and agriculture. pp. 18-20. World Review Part I. Rome. Italy.

FAO (Food and Agriculture Organization). 1997. *Small-Scale Irrigation For AridZones: Principles And Options*. FAO, Rome.

FAO.2006. Special Report FAO/WFP crop and food supply Assessment mission to Ethiopia. 24 February, 2006. [On line accessed on 09 April, 2008 at http://www.fao.org/docrep/008/j7071e/j7071e00.htm#48]

FDRE (Federal Democratic Republic of Ethiopia) (2002), Ethiopia: Sustainable Development and Poverty Reduction Program. Addis Ababa: Ministry of Finance and Economic Development.

FDRE (Federal Democratic Republic of Ethiopia) (2005), Ethiopia: Building on progress: A plan for accelerated and sustained development to end poverty. Addis Ababa: Ministry of Finance and Economic Development.

Federal Democratic Republic Ethiopia Ministry of Agriculture (2013), Realizing the Potential of Household Irrigation in Ethiopia, Household Irrigation Sector Strategy.

Gebregziabher, G. 2008. Risk and Irrigation Investment in a Semi-Arid Economy, (PhD) Thesis, Department of Economics and Resource Management, Norwegian University of Life Sciences, Norway.

GIZ (2006): Financing Small-Scale Irrigation in Sub-Sahara Africa. Geseelschaft fuer Internationale Zusammenarbeit (GIZ).

Haile GG, Kasa AK (2015). Irrigation in Ethiopia: A review. Acad. J. Agric. Res. 3(10): 264-269.

Halcrow and Partners. 1989. *Master Plan for the Development of Surface Water Resources in the Awash Basin*. MWR, Government of Ethiopia,Addis Abeba.

Hazell, P., and L. Haddad. (2001). Agricultural research and poverty reduction. (2020), Vision discussion Paper 34. Washington, D.C.: International Food Policy Research Institute.

House Hold Irrigation Strategy. Agriculture Transformation Agency of Ethiopia. 2013

Hussain, I., R.E., Namara, and S. Madar. 2004. Water for food security for the poor. A collection of thematic papers. Asian Development Bank. Colombo, Sri Lanka.

Hussain and m. A. Hanjra Irrigation and Drainage. 53: 1–15 (2004) Copyright # 2004 John Wiley & Sons, Ltd IWMI. Colombo, Sri Lanka

IFAD (International Fund for Agricultural Development). 2005. Special country program phase II (SCP II) interim evaluation report number 1643-ET. Ethiopia.

Irrigation Water Users' Association formation and development manual.The Project for Capacity Building in Irrigation Development (CBID) By JICA & OIDA May, 2014

IWMI (International Water Management Institute) (2005). Experiences and opportunities for promoting small scale micro irrigation and rain water harvesting for food security in Ethiopia, Working paper 98. IWMI : Addis Ababa.

Jayne, T.S., D. Mather & E. Mghenyi, 2006. Smallholder farming under increasingly difficult circumstances: Policy and public investment priorities for Africa. *International Development Policy Syntheses*.

Jorma R. 1999. *Financing Irrigation Development and Private Sector Initiative with Special Reference to Sub-Saharan Africa:* FAO E-mail conference 15 March to 23 April. Rome

Jurriens M., Zerihun D., Boonstra, J. and Feyen J. 2001. *SURDEV: Surface Irrigation Software.* Publication 59, ILRI, Wageningen.

Kamara C. S., and Haque I. 1991. Soil Physics Manual. Working Document No.B12. Soil science & Plant Nutrition Section: International LivestockCenter for Africa. Addis Abeba, Ethiopia.

Kumar, D. 2003. Food security and sustainable agriculture in India. pp. 1-2. The water management challenge. Working paper 60. International Water Management Institute. Colombo, Sri Lanka.

Kloos H. Small Scale Irrigation and Food Production in Ethiopia. A review. In: Ethiopian Journal of Development Research Vol.12, No.2. Institute of Development Research, Addis Ababa University, April 1990.

Lisa Smith, Harold Aderman and Dede Adeayoun, (2006), International Food Policy a Research Institute. Research Report No. 146, Washington DC.

Makombe G, Kelemework D, Ared, D (2007). A comparative analysis of rainfed and irrigated agricultural production in Ethiopia. Irrigation and Drainage Syst.

McCornick P.G., Kamara A.B. and Girma Tadesse. 2003. *Integrated water and land management research and capacity building priorities forEthiopia. Proceedings of a MoWR/EARO/IWMI/ILRI international workshop held at ILRI, Addis Ababa, Ethiopia, 2–4 December 2002.*

MENGISTU A. Ethopia: Country Pasture/Forage Resource Profiles. Suttie and Reynolds, July 2003.

MoA (2011a). Natural Resources Management Directorates. Small-Scale Irrigation Situation Analysis and Capacity Needs Assessment, Addis Ababa, Ethiopia.

MoA (2011b) Natural Resources Sector, Small-Scale Irrigation Capacity Building Strategy for Ethiopia, Addis Ababa, Ethiopia.

MoFED (Ministry of Finance and Economic Development).2002.Sustainable development and poverty reduction program. pp. 1-87. Addis Ababa, Ethiopia.

MoWIE (2013). Water Resources of Ethiopia; The National and International Perspective, Awareness creation Program prepared for Public Relation officials, Addis Ababa, Ethiopia.

MoWR (Ministry of Water Resources).2001. Irrigation development strategy (Component of the water sector development program). Draft report. Ethiopia, Addis Ababa.

Ngigi, S.2002. Review of irrigation development in Kenya. pp. 35-37. International Water Management Institute. Colombo, Sri Lanka

Pankhurst, A and Gebre, A., (2002): The Current Understanding of Poverty and wellbeing in Ethiopia, paper to the inaugural workshop of the ESRC Research Group on

Wellbeing in Developing Countries, January 13th-17th, 2003, Bath, United Kingdom.

Rosegrant, M., and P. Hazell. (2000). Transforming the rural Asian economy: The unfinished revolution. Hong Kong: Oxford University Press.

Smith, S and Ross, C (2006). Organizing out of Poverty: how the Syndicoop approach has worked in East Africa

Tesfaye Lemma (2003): Livelihood strategies in the context of population pressure: A case study in theHararghe highlands, Eastern Ethiopia. Ph.D. dissertation. University of Pretoria.22p.

Timmer, C. P. (1988). The agricultural transformation. In Handbook of development economics, vol. 1, ed. H. Chenery and T. Srinavasan. Amsterdam: North Holland.

Timmer, C. P. (1997). Farmers and markets: The political economy of new paradigms. American Journal of Agricultural Economics 79: 621–627.

Turner B. 1994. *Small-Scale Irrigation In Developing Countries*. Land Use Policy, 11 (4) 251-261.

UNIDO & GTZ, 2008. *Creating an enabling environment for private sector development in sub-Saharan Africa*. Vienna: UNIDO

Volamen, R., (2009). "Towards Multi-Functional Global Food Systems. COGECA, LuxemburgAgricultural Council.

_____Wolmera Woreda Office of Agriculture, 2013

World bank (2003). Reaching the rural poor, a renewed strategy for rural development. Washington, DC: World Bank.

World Bank, (2007). Community driven development. <http://web.worldbank.org/%20WBSITEEXTERNAL/%20TOPICS/%20EXTSOCIALDEVELOPMENT/EXTCDD/0,,contentMDK:20250804%7EmenuPK:535770%7EpagePK:148956%7EpiPK:216618%7EtheSitePK:430161,00.html

Zhou, Y., Zhang, Y., Abbaspour, C.K., Yang, H. and Mosler, J.H. 2009. Economic impacts on farm households due towater reallocation in China's Chaobai watershed. *Agricultural Water Management* 96:883–891.

Appendix I

Appendix 1. List questionnaires used for House Hold Irrigation Technology User Farmers interview

Note:- Dear Respondent: the purpose of this interview is to gather information on the role of House Hold Irrigation Technologies in Improving the living standard of participants in 3 kebeles of Wolmeraworeda, Oromia Region**.** The information generated through this questionnaire will be used only for the purpose mentioned above. Thank you for the time and information that you provided us.

I. General Information

1.1. Date of interview: ……..

1.2. Name of Interviewer: …….

1.3. Village: ……

1.4. Name of the Irrigation association: ……

1.5. Date of foundation……

1.6. Agro-Ecological zone: ……

II. Personal Profile

2.1. Name of interviewee……..

2.2. Sex Male ☐ Female ☐

2.3. Age……

2.4. Ethnic group …….

2.5. Educational level Illiterate ☐ Literate ☐ Primary school ☐ Secondary High school ☐ > high school, ☐ TVET ☐

2.6. Marital status Married ☐ Unmarried ☐ Divorced ☐ Widowed ☐

2.7. Family size …….

2.8. Family composition Table 1

	Age group (year)	Male	Female	Total
	Below 5 years			
	5 – 18			
	18 – 65			
	> 65			

III. Role of House Hold Irrigation Technologies in improving the living standard of its member

3.1. Source of Income of the house holds

3.1.1. Please rank major source of income according to their importance to the households

Table 2

No		Rank	
		Before using HITs	After using HITs
1	Crop production		
2	Livestock production		
3	Honey harvesting		
4	Wage labor		
5	Petty trade		
7	Others(specify)		

3.2. Household & Natural capital profile

3.2.1. Would you tell us your herd size?

Table 3

No	Items	Before using HITs	After Using HITs
1	Cattle		
2	Shoats (sheep &goat)		
3	Equines		
4	Chicken		
5	Bee colonies/hives		
6	Others (specify)		

3.3. What is/was total landholding of the household?

Table 4

Type of landholding	Before using HITs			After using HITs		
	Rented	Own	Others (specify)	Rented	Own	Others (specify)
Farm land						
Home stead						
Others (specify)						

3.4. What was/is the major land use pattern of your household?

Table 5

Land use type	Before using HITs			After using HITs		
Forest land						
Cropland/vegetables						
Grazing land						
Others (specify)						

Why the changes, if any? ----------

IV On-Farm production

3.5 **How do you select high value crops for production?**

a. Traditional way of selection based on soil suitability
b. Through advice from an extension agent / Development Agent
c. By implementing the training taken with other farmers

3.6 **How many times per year do you grow crops and/or vegetables using irrigation?**

a. One b. Two c. Three

3.7 Do you use cropping calendar?

a. Yes b. No

Training

3.8 Did you get training on irrigated vegetable production?

a. Yes b. No

3.9 **Who provided you with the training?**

a. Governmental organization

b. NGO

3.10 **What were the topics of the training?**

a. Crop/ vegetable production c. Marketing of products

b. Post-harvest handling d. All

V. Access to improved agricultural inputs/technologies

3.11 **Did you have access to inputs such as improved seeds, fertilizers, agrochemicals and water lifting technologies?**

a. Yes to all

b. Only seeds and fertilizers

c. Seeds, fertilizers and agrochemicals

d. None

3.12 From where did you get all vegetable package inputs?

a. From Agricultural office b. From Farmers Cooperative Union

a. Input Supply Agency d. Others (specify)

3.13 What is your source of irrigation water?

a. Pond b. Well c. River/stream d. Borehole

3.13What type of vegetable production system did you adopt?

a. sole cropping,

b. mixed with other crops

3.15 What were the vegetable production constraints on your farm? (Rank the problems in order of severity)

a. Getting improved inputs with reasonable price and at the right time

b. Pump breakdown

c. Lack of storage facilities

d. Lack of support in extension services

e. Getting an honest buyer

3.16 Did you get an adequate extension support throughout your production period from

experts?

a. Yes b. No c. To some extent

3.17 Were you able to increase productivity in terms of yield as a result of the

aforementioned interventions as compared to the previous year?

a. Yes b. No c. To some extent

Access to financial credit

3.18 Did you take outcredit/loan for facilitating purchase of agricultural inputs /or

marketing of out puts?

a. Yes b. No

3.19 Who provided you with the loan?

a. Bank
b. Local credit and saving cooperative
c. Cooperative union
d. Local money lenders

3.20 What were the constraints in getting financial services?

a. Collateral for the loan
b. Lack of confidence
c. Avoidance of risk

VI On farm management and Post-harvest management

3.21 Was storage of Vegetable production a problem to you?

a. Yes b. No

3.22 How much of the production was damaged in the field after harvest?

a. About 10%
b. About 20%
c. About a quarter
d. I don't have idea

3.23 Did you call toll free extension service (8028) using your mobile and got useful advice?

a. Yes found it useful
b. Yes but found it not relevant

c. No I couldn't use it

VII Market Linkage and information

3.24 Do you easily find buyers for your vegetable products you take to markets?

a. Yes b. Difficult to find

3.25 Is there any assistance from the woreda in relation to marketing?

a. Yes, but not adequate
b. No support at all

3.26Where do you acquire information about market? Product and input price?

a. From cooperative
b. From middle men
c. From buyers
d. From media

3.27 The role played by middle men in the sale of vegetable products is beneficial

a. Strongly agree b. Agree c. Neutral d. Disagree e. Strongly disagree

VIII Pump maintenance/manufacturing training

3.28 Are there trained engine pump maintenance and manual pump manufacturers in the woreda?

a. Yes b. No c. I don't know

3.29What are your opinions on the service that the trained service providers render you?

a. I often use the service
b. I don't know whether the service exists
c. The service is not available
d. I have no access to use the service

3.30How did you find the price of the locally manufactured irrigation pump?

a. Expensive
b. Fairly reasonable
c. I don't know

3.31 How did you find the service charge for engine pump maintenance?

a. Expensive
b. Fair
c. I don't use the service

3.32 Your comment on the quality of the maintenance service

a. Good quality
b. Fair
c. Poor that requires frequent visit of the mechanic

3.33 Your comment on the quality of the manually manufactured pump

a. Good quality
b. Fair
c. Poor that requires frequent maintenance

3.34 **Types of pumps you use to lift irrigation water**

a. Suction only Treadle pump
b. Overflow Treadle pump
c. Rope and Washer pump
d. Kick Start/ Money Maker
e. Motor Pump

3.35 Quantity of improved seeds, fertilizers and agrochemicals used before and after adopting HITs for the years 2005-2007 E.C

Table 6

	Before using HIT			After using HIT		
Improved seed	2005	2006	2007	2005	2006	2007
Teff						
Wheat						
Potato						
Tomato						
Onion						
H. Cabbage						
Carrot						
Barley						
Maize						
Fertilizer (Qt)						
Pesticide(Lts)						
Pump						

3.**36 Production in quintals before using and after using HITs in the years 2005-2007 E.C.**

Table 7

	Before using HIT			After using HIT		
Crop/Vegetable Type (Qt)	2005	2006	2007	2005	2006	2007
Teff						
Wheat						
Potato						
Tomato						

Onion						
Head Cabbage						
Carrot						
Barley						
Maize						

3.37 How much of what you produce did/do you sell in the market or did/do you consume at home?

Table 8

s/n	Major Sources/ products	Unit	**Before using HITs**			**After using HITs**		
			Average production per year	Consume at home	Market	Average production per year	Consume at home	Market
1	Grain							
	Maize							
	Teff							
	Wheat							
2	Vegetables							
	Potato							
	Cabbage							
	Carrot							
3	Fruit trees							
4	Coffee							
5	Hive/ honey							
6	Livestock							
7	spice							
8	Others (specify)							

Why the changes, if any? ----------

--------**Average income**

- Before **using HITs**, Monthly----------Annual----------
- After **using HITs**, Monthly ---------- Annual----------

3.38 Do you have saving before using HITs?

A) Yes B) No

If yes, how much……

3.39 Do you have saving now?

A) Yes B) No

If yes, how much……

3.40 Change in overall Livelihood

Table 9

Variables	SA	A	N	D	SD	Total
Change in occupation						
Chang in income source						
Chang in income						
Change in Saving						
Change in Assets						
Change in health status						
Change in education status						
Change in participation on social affairs						
Change in food security						
Resilience to shock						

Note: Figures within parenthesis shows percentages.
SA=Strongly Agree, **A**=Agree, **N**==Neutral, **D**=Disagree, **SD**=Strongly Disagree

Employment Opportunity

3.41 **Were you employed before using HITs? Yes No**

If, yes, what type of employment

1. ----------
2. ----------

How many Days per year? .....

3.42 Are you engaging family labor? Yes No

If yes, how many days per year? ……

3.43 **Are you engaging labor other than family member?** Yes No

If yes, How many laborers did you employ before **using HITs** ……

How many laborers do you employ after **using HITs** ……..

Why the changes, if any? ----------

3.44 **To what extent does involvement in HHI Technology use improved the life of your family?**

a. To a great extent b. To some extent c. hardly

3.45 **Why do you think model farmers get a better yield than the rest of the farmers?**

a. They get exceptional support b. They make use of trainings and exposure visits

c. They take risks in using improved inputs d. Their land is more fertile

Annex II. Interview for Farmer's Cooperative leaders

Indira Gandhi National Open University Master's Program in Rural Development

This questionnaire aims at knowing the role of HITs in in improving the living standard of participants.

We politely request your help to inform us with what is happening in the community and therefore participate in our research. For its success all the information you provide us will be confidentially recorded as reported and used only for this purpose.

Thank you

Ayele Sileshi

Interview schedule for Farmer's Cooperative leaders

A. Personal information

Please tick beside the appropriate choice with an ✓

No	**Age**	**Sex**	**Marital status**	**Religion**	**Level of education**
1	20-25	Female	Married	Protestant	Illiterate
2	26-35	Male	Un married	Muslim	Primary
3	36-45		Divorced	Christian	Middle
4	46and above		Widow	catholic	Non-formal education
			Widower	Any other	

Name of enumerator----------

B. Detailed questions

1. **How long have you been working in Farmers Cooperative?**

a. Less than 2 years b. 2-4 years c. Above 4 years

2. **What types of Associations exist in your area?**

   a. Farmers b. Women c. Youth d. All

3. **What types of development activities are being undertaken in your area?**

   a. Construction (road, school, bridge) c. Clinic

   b. Irrigation and water supply d. Market shade

4. **How do you support member farmers practicing HITs?**

   Through provision of

   a. Inputs b. Training c. Credit d. Output marketing e. All

5. **Do you agree that irrigated crop production helps improve the life style of farmers?**

   a. Strongly agree b. agree c. disagree

6. **What has been the attitude of local elders about irrigation?**

   a. Appreciative b. Cooperative c. Indifferent

7. **What according to you motivates farmer's involvement in irrigation?**

   a. Money b. Awareness c. Education d. All of the above

8. **How do you initiate the involvement of women farmers in irrigated vegetable production?**

   a. Awareness creation b. Affirmative action (giving priority)

   c. No women farmers in irrigation so far

9. **To what extent do you think that irrigation has brought women's access to decision making in the household and in the community?**

   a. To a great extent b. To some extent c. Hardly

10. **Do you believe that you have the adequate knowledge about principles of Associations, values and philosophy?**

a Yes b No

11. **How are decisions made in meetings**

a. Majority vote after discussion b. By cooperative leaders

b. Endorsement of proposal raised by leaders

12. **How far did the cooperative promote HITs to be adopted by majority of farmers?**

a. Not much b. To some extent c. Extensive

13. **Do you carry out/Collect input demand of farmers to link to buyers?**

a. Yes b. Partially c. No d. Simply order inputs from experience

14. **Do you agree that members are equally treated in getting service from coops?**

a. Strongly agree b. agree c. disagree

15. **Do you own or have you thought of building a warehouse to be used in common?**

a. Yes b. No

16. **What are the challenges that farmers using HITs face according to your experience?**

a. Lack of quality inputs b. Lack of financial credit c. Fear that irrigation is an all year round activity d. Lack of fair price for produce

17. **Do you cooperate with other neighbouring cooperatives/ Associations?**

a. Yes b. No

18. **Have you thought of maximizing the use of FTCs**

a. Yes b. A few times c. No

19. **Which of the indicators are visible in the improvement of the life style of HIT userfarmers?**

a. Asset development b. Sending children to school

c. Reduced health problem d. Increased nutrition intake e. All

20. **Do you observe an increased wealth for the cooperative?**

a. Yes b. No

Mention a few points that reflect this.

Annex III

Questionnaire for Woreda Experts
Dear/sir

I am conducting a study on "The role of HIT's **(House Hold Irrigation Technologies)** in improving the living standard of participant farmers with special reference to Wolmeraworeda". In this context, I request you to kindly fill up this questionnaire and return to me at your earliest possible time. I assure you that the information given by you will be kept confidential and will only be used to prepare my dissertation and be a part of my dissertation for MA in Rural Development of Indira Gandhi National Open University.

Kindly mail this questionnaire duly filled in to my address which is given below

Sincerely,

Name and address of Investigator:
Ayele Sileshi
P.O.Box 23595 code 1000, Addis Ababa, Ethiopia

C. Personal information

Please tick beside the appropriate choice with an ✓

No	**Age**	**Sex**	**Marital status**	**Religion**	**Level of education**
1	20-25	Female	Married	Protestant	Illiterate
2	26-35	Male	Un married	Muslim	Primary
3	36-45		Divorced	Christian	Middle
4	46and above		Widow	catholic	Non-formal education
			Widower	Any other	

.

Name of enumerator----------

D. Detailed questions.

21. **How long have you been working in the Woreda as an expert?**

a. Less than 2 years b. 2-4 years c. Above 4 years

22. **How do you support member farmers practicing HITs?**

Through provision of

a. Inputs b. Training c. Credit d. Output marketing e. All

3. Which type of farmer do you support?

a. Model farmers b. All farmers equally c. Educated youth

4. Do you agree that irrigated crop production helps improve the life style of farmers?

a. Strongly agree b. agree c. disagree

b. What is the extent of farmers accepting training on technology access?

a. Active b. Doubtful c. Very eager

c. What according to you motivates farmer's involvement in irrigation?

a. Money b. Awareness c. Education d. All of the above

d. How do you assist farmers produce quality products using cropping calendar?

a. Training b. demonstrating best practices

b. Use free dial 8028 for extension service d. All e. None

e. How do you assist farmers select HVCs (High Value Crops)?

a. They use no HVC selection tool b. Already gave training c. Traditional

f. How do you assist farmers in irrigation water management?

a. Already gave training c. Follow their traditional ways

b. Demonstrate on FTCs d. Encourage them to use 8028 Free Dial

g. How do you support them in crop protection, especially epidemic pests?

a. Awareness creation b. Early warning c. Report incidence to Woreda

h. What challenging support question did you face in your career?

a. Failing technology c. Resistance from farmers e. All

b. Avoidance of risk d. Provision of quality inputs on time

i. Do you collect demand assessment of inputs of farmers using HITs and link to buyers?

a. Yes b. To some extent c. No

j. How do you see the participation of farmers in HITs would bring a better future for farmers and the country?

a. Positive b. A lot of support is needed c. Farmers are not interested

k. What are the main challenges in HIT implementation

Table 2

Ser.No	Provision of /Lack of Quality inputs	Strongly Agree	Agree	Disagree
1	Fertilizers			
2	Improved seeds			
3	Pesticides			
4	Irrigation pumps			
5	Spare parts			
6	Storage facilities			
7	Market			

15. The higher the area of irrigation in agriculture presumes a higher productivity of crops and higher food security and even improved life style. Is this statement true?

a. True b. False c. Can't say

16. How often do you check on the support provided by development agents to Farmers

a. Once per month b. Every 2 months c. Every 3 months

17. How often do you assist DA's in their effort to support farmers?

a. Every 3 months b. Every 2 months c. Whenever they request

Annex IV

Interview Schedule for Development Agents
Dear/sir

I am conducting a study on "The role of HIT's in improving the living standard of participant farmers with special reference to Wolmeraworeda". In this context, I request you to kindly fill up this questionnaire and return to me at your earliest possible time. I assure you that the information given by you will be kept confidential and will only be used to prepare my dissertation and be a part of my dissertation for MA in Rural Development of Indira Gandhi National Open University.

Sincerely,

Ayele Sileshi

E. Personal information

Please tick beside the appropriate choice with an ✓

No	**Age**	**Sex**	**Marital status**	**Religion**	**Level of education**
1	20-25	Female	Married	Protestant	Illiterate
2	26-35	Male	Un married	Muslim	Primary
3	36-45		Divorced	Christian	Middle
4	46and above		Widow	catholic	Non-formal education
			Widower	Any other	

Name of enumerator----------

F. Detailed questions

b. How long have you been working in the kebele as a Development Agent?

a. Less than 2 years b. 2-4 years c. Above 4 years

c. How do you support member farmers practicing HITs?

Through provision of

a. Inputs b. Training c. Credit d. Output marketing e. All

3. **What is the support provided to farmers who practice HHI using technologies?**

a. Less than 25% of my time c. 51-75% of my time

b. 25-50% of my time d. 76-100% of my time

l. Which type of farmer do you support

a. Model farmers b. All farmers c. Not mandated to support irrigation

b. How is the response of farmers to the use of HITs and ease of adoption?

a. Active b. Doubtful c. Very eager as far as inputs are provided

c. Do you agree that irrigated crop production helps improve the life style of farmers?

a. Strongly agree b. agree c. disagree

b. What is the extent of farmers accepting training on technology access?

c. Active b. Doubtful c. Very eager

c. What according to you motivates farmer's involvement in irrigation?

a. Money b. Awareness c. Education d. All of the above

d. How do you assist farmers produce quality products using cropping calendar?

a. Training b. demonstrating best practices

b. Use fee dial 8028 for extension service d. All e. None

c. How do you assist farmers select HVCs (High Value Crops)?

a. They use no HVC selection tool b. Already gave training c. Traditional

b. How do you assist farmers in irrigation water management?

a. Already gave training b. Traditional

c. Demonstrate on FTCs d. Encourage them to use 8028 Free Dial

b. How do you support them in crop protection, especially epidemic pests?

b. Awareness creation b. Early warning c. Report incidence to Woreda

c. What challenging support question did you face in your career?

a. Failing technology b. Resistance from farmers e. All

c. Avoidance of risk d. Provision of quality inputs on time

b. Do you carry out demand assessment of inputs of farmers using HITs?

a. Yes b. To some extent c. No

b. How do you see the participation of farmers in HIT would bring a better future for farmers and the country?

a. Positive b. A lot of support is needed c. Farmers are not interested

b. What are the main challenges in HIT implementation

Table 2

Ser.No	Provision of /Lack of Quality inputs	Strongly Agree	Agree	Disagree
1	Fertilizers			
2	Improved seeds			
3	Pesticides			
4	Irrigation pumps			
5	Spare parts			
6	Storage facilities			
7	Market			

17. The higher the area of irrigation in agriculture presumes a higher productivity of crops and higher food security and even improved life style. Is this statement true?

a. True

b. False

c. Can't say

PERFORMA FOR SUBMITION OF M.A (RD) PROPOSAL FOR APPROVAL

Signature:----------

Name: ----------

Address of Guide: ----------

Name and Address of the student: Ayele Sileshi Haile

Addis Ababa, Ethiopia

Mobile: 251911487112, 251923279189

Enrolment No: ID1404002

Date of submission:

Name of the student centre: St. Mary's University

Name of Guide: ----------

Title of the Project:-*An Evaluation on the Effectiveness of House Hold Irrigation Technologies on the lives of farmers:The Case of Dhuffa, BerfeteTokoffaand Kore OdoKebeles in WelmeraWereda, Western Shewa of Oromia*

Signature of the student----------

Approved/ Not Approved

Date:

An evaluation on the effectiveness of House Hold Irrigation Technologies on the lives of farmers:The Case ofDhuffa, BerfeteTokoffa and Kore OdoKebeles in WelmeraWereda, Western Shewa of Oromia

BY
AYELE SILESHI HAILE

RESEEARCH PROJECT PROPOSAL SUBMITED TO THE MASTER'S PROGRAME IN RURAL DEVELOPMENT OF INDIRA GANDHI NATIONAL OPEN UNIVERISITY /IGNOU/

New Delhi, India
March, 2015
Addis Ababa, Ethiopia

Contents Pages

1. 0 **Introduction** ----------4
1.1 Background---------- 4
1.2 Statement of the problem ---------- 6
1.3. Terminologies ----------7
1.4. Objective of the study ----------8
1.5. Research questions ----------8
1.7. Scope/Universe of the study ----------9
1.8. Significance of the study----------9
2. **Research Design and Methodology** ----------10
2.1. Description of the study area----------10
2.2 Method of the study----------11
2.2.1. Quantitative method----------11
2.2.2. Qualitative method----------11
2.2.3. Sample and Sampling techniques ----------12
2.2.3.1. Sampling techniques----------12
2.2.3.2 .Sample size----------12
2.3 .Data collection and procedures ----------12
2.4 Data processing and analysis----------13
Chapterization----------14
References----------16
Annexes

Background of the study

1. Introduction

Increased smallholder productivity and value-addition in the agricultural sector are core elements of the Ethiopian Government's approach to poverty reduction. The Agricultural Growth Program (AGP) is a component of this broad effort that had already commenced in 2011. The AGP, as proposed, is a five-year program which has as the primary objective "to increase agricultural productivity and market access for key crop and livestock products in targeted *woredas* with increased participation of women and youth". The AGP will:

- Focus on agricultural productivity growth;
- Target 83 *woredas* in Amhara, Oromia, SNNP, and Tigray — *woredas* deemed to possess high agricultural growth potential that can be realized with appropriate interventions. Identify key commodities based on a variety of considerations — from current share in production and potential marketability to possibilities for spatial spill-over effects; and
- Emphasize greater participation of women and young people.

The AGP has two main components. *Agricultural Production & Commercialization* constitutes the first component and its objectives are:

"To strengthen the capacity of farmer organizations and their service providers to scale up best practices and adopt improved technologies in production and processing, and to strengthen marketing and processing of selected commodities through engagement with private sector stakeholders".

The second component, *Small-scale Rural Infrastructure Development and Management,* will "support the construction, rehabilitation and/or improvement, and management of

small-scale rural infrastructure to improve productivity, and to further develop and increase the efficiency of key value chains through improved access to markets

Household irrigation in context.

Accounting for almost half of Ethiopia's gross domestic product and employing 85% of the population, agriculture is the primary engine of the national economy of Ethiopia, with over 95% of the sector's output produced by smallholder farms. Even as the sector has been characterized by continuous growth over the past decade, many of the country's smallholder farmers continue to face food insecurity and low incomes—official estimates suggest that average smallholder income from the sale of crops is less than 3,500 ETB/year.

Traditional smallholder agricultural production in Ethiopia's cropping zones is rain-fed, heavily dependent on the *kremt*rains of June through September. This dependence has significant economic and health implications for smallholder farmers and rural populations. With variations in productivity and time of harvest come peaks and ebbs of food access: most supplemental food aid is disbursed in this period as well. For the rural poor, who supplement their livelihoods as agricultural laborers, rain-fed agriculture provides only intermittent and less-reliable opportunities for employment.

Cognizant of the fact that Transformation Agencies have brought significant changes in Eastern Asia and few African countries, the Ethiopian government had shown interest for the replication of these systems.The Ethiopian Agricultural Transformation Agency is an Agency mandated by proclamation by the Ethiopian Federal Democratic Republic of Ethiopia to identify potential bottlenecks that have impeded production and productivity in the agricultural sector and solicit solutions to these problems. Household Irrigation Program at the Ethiopian Agricultural Transformation Agency (EATA) engages public, private and

non-governmental stakeholders to support strategic planning, strengthen implementation capacity and test innovative models across all the value chains; so as to: (i) increase income of smallholder farmers, (ii) improve their food security throughout the year, and (iii) catalyse growth in farming communities. According to the current working definition of ATA, household irrigation has a command area of less than 5 ha, for plots of fewer than ten households. Household irrigation is independently managed by households for it does not require sophisticated infrastructure and engineering expertise for both construction and maintenance activities.

Household irrigation requires promoting the use of both waterlifting and water-saving technologies, supplying inputs for high-value horticultural crops, applying best practices in agronomy and water management, proper post-harvest handling practices, and ensuring reliable market linkages for the resulting output. Towards this, Household Irrigation Sector Strategy has been designed aligned with the prevailing agriculture and rural development policies and strategies. The strategy helps as a systematic guide to address household irrigation related challenges across the value chains of: (i) Research, knowledge and policy; (ii) technology access & adoption; (iii) Input production, procurement and distribution; (iv) On-farm production; (v) Post-harvest handling; (vi) Market linkages, and (vii) Demand sinks.

2. Statement of the problem

The farmers residing in the fertile plain of the Dhuffa, BerfeteTokoffa and Kore oddokebeles have been endowed with a fertile land, adequate moisture from the bimodal rainfall, a suitable weather for the growing of different types of crops and livestock and a conducive

weather for a healthy living. Despite all these commendable endowments, the farmers in these villages used to run-through a hand- to-mouth style of living.

The annual sales of their agricultural produce do not suffice to lead a modest life. There is no change in their life style and they are forced to remain under the realm of poverty.

This stagnant mode of living could not trigger development of infrastructure either. They were far from schools, health centers, police station and other minimum service providing facilities.

Their children have to go a long way to get elementary education, women have to travel a lot to get water for drinking and sanitation, search for fire wood and go to flour mills.

All of these were due to lack of the exposure to new methods of improving agricultural production and productivity. To get an increased production and productivity, farmers must at least select the proper high value crop, use improvedseeds, appropriate fertilizers, crop protection technologies and post-harvest technologies.

There is also the opportunity for farmers to use house hold irrigation technologies along the value chain that commences with the provision of information, agronomic trainings, agricultural inputs, irrigation water management trainings and arrangement of conducive situations for the marketing of the produce of farmers.

However, empirical evidence about how these participant households contribute to the rural welfare and development their area on smallholder-based agriculture in WolmeraWoreda is yet scanty and is required to have research or study in order to realize their potentials in transforming the traditional rain fed subsistence agriculture into a dependable irrigated cultivation at least producing more than once. Therefore, this study

has been carried out to provide some new empirical evidence that may help us understand the conditions of participant households in improving their living standards in the study area. This evidence will provide new insights for policymakers, researchers, and development practitioners who are encouraged by the flourishing of house hold irrigation practices along the value chain as a means of benefiting the rural poor.

3. Important terms used in the project

In doing research operationalizing/giving the operational definitions for the dependent and explanatory variables need to have clear understanding in what the researcher is going to do. Evidence shows that house hold irrigation using manual pumps has enabled farmers be more actively engaged during the dry season and get additional income for their families.

So, the impact of house hold irrigation by using manual pumps in influencing or changing the livelihood assets of farmers was considered and analyzed in this research.

House Hold: A family that is living in a definite residential area usually composed of a husband, a wife, children, hired labourer and other dependants sharing the earnings of the family.

Irrigation: The practice of providing a sustainable source of water supply for a crop under consideration

Livelihood: a livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future (Carney, 1998).

High value crops: Crops that require a significantly higher input, higher focus, better care and protection as they are supposed to give a better yield and finally higher sales.

Vegetable crops: these are crops that are produced on a smaller amount of land, usually near the source of water and not far from residential areas. They require a higher care and give better yield than other types of crops.

House Hold Irrigation Technologies: these are improved agricultural inputs that are directly related to the activities of irrigated horticulture that are anticipated to ease the burden of the farmer, enhance quality production and help increase productivity thereby ensure the profitability of the farmer.

Improved seeds: these are improved planting materials that are imported from abroad or produced with the maximum care and expertise ensuring a high germination and or survival percentage after transplanting

Brokers: are middle men that play a very significant role in linking producers and buyers, always trying to ensure the benefit they reap from both parties at times.

Etfruit: is a parastatal Enterprise mandated to regulate price of vegetables and fruits by intervening in the wholesale as well as the retail market

4. Objectives of the present study

The main objective of the study is to evaluate the assessment of the effect of house hold irrigation technologies in improving the lives of the farmers who are living and cultivating crops.

Specific objectives

a) To evaluate the utilization level of modern agricultural inputs by households in their cultivation of high value crops,
b) To assess the improvement in increased production and productivity.

c) To gather data and evaluate the economic benefit the farmers who participated in HHI in the kebeles have achieved,

d) To check whether the complete process in the house hold irrigation value chain has been implemented and succeeded.

5. Research questions

The research is initiated to answer four main questions that persist in the lives of the small holder farmers who have been living in this area for generations. There is the practice of irrigation here and there in its traditional ways of simply applying water to a certain vegetable, fruit tree, ratoon or wild cabbage and green pepper.

Do the farmers practice a major irrigated vegetable production?

Given that irrigated vegetable production is expensive, are the farmersaware that non improved practices reap off their assets?

Do they understand that misuse of the opportunities in an improved irrigation could lead them to disaster?

Have they passed the point of no return to rudimentary agricultural practices?

6. Universe of the study

The study is confined to the three kebeles; namely: Dhuffa, Bekeka (Kore Oddo) and BerfeteTokoffa which are found in Oromia National Regional State, Finfinezuria Special Zone, WolmeraWoreda which is about 42 kilometers from Addis Ababa.

In the assessment of these areas, certain important features would be taken into consideration. The research will only focus on farmers, cooperative leaders and Development Agents who work in the three kebeles.

Due to limited time and resource availability, it will not be possible to cover and survey the entire farming population in the Woreda. Ethiopia is a diverse nation in terms of culture, social capital, agro ecology, resource endowment and ethnic groups. Hence, this study cannot be typical or warrant generalizations for the entire country in general, or the region in particular. Yet, recommendations and policy implications of this study could be used in other locations having comparable or similar context (socio-economic characteristics).

All the necessary arrangements would be made for the collection of data.

7. Significance of the study

Irrigation as a whole, but particularly house hold irrigation is the most neglected sector in the socio economic relation of rural development. There are no research undertakings and recommendations to be provided to household irrigation participants. The extension agents do not have adequate knowledge on the operations, management and control of irrigation.Farmers use their own experiences or meagre exposure they have encountered working with NGO's or different sized schemes found in their vicinity.

Cognizant of the fact that many Asian countries have come out of poverty using irrigation, all governmental, private, NGO's and all concerned shall give special attention and support to House Hold Irrigation.

Though the government has currently given attention to segregated sizes of irrigation based on their size, there are no assessments and reviews carried out on the performance to take the required action.

Hence it is high time to carry out lots of evaluations on the performance of these house hold irrigation interventions before it is too late to realize that things have gone wrong.

8. Research Design and Methodology

8.1. Description of the study area

8.1.1. Location

WolmeraWoreda

Wolmeraworeda is located in Finfinezuria special zone of Oromia regional state. Total area of the woreda is around 66,243ha of land. The population of the woreda is estimated to be 102, 263 out of these 51,037 are male and the remaining 50,228 are female. Administratively the woreda is divided into 2 urban and 23 rural kebeles. The administrative center for the woreda is based in Holeta town which is located 40km to west of Addis Ababa. Agro ecologically 61% of the woreda belong in Dega and 39% in Woinadega zones. According to the information from the woreda irrigation authority office the total irrigable land potential of the woreda is 8,845 ha out this currently 7,703 ha is cultivated using irrigation. Irrigation is primarily used for production of vegetables.

Table 1. Land use pattern of WolmeraWoreda

Total Area	66,243
Arable land	37,601
Cultivated land	37,401
Grazing land	9,763
Forest and bush	10,879
Area for investment, construction and other purposes	5,942

Source: Wolmeraworeda Agricultural and Rural Development Office

8.1.2 Agricultural Activities

Crop farming is the main source of livelihood for most of the farmers in the woreda. Wheat, teff, and barley serve as the major cash crop of the woreda. In addition farmers plant

eucalyptus as alternative source of cash. Nowadays, potato production is widely practiced as one source of income for smallholders of the woreda.

Because of the efforts made by the research personnel in Holetta Agricultural Research Center, farmers found in the woreda are becoming beneficiaries and have reached to the level of producing and selling high quality potato seeding material to farmers of the neighboring woredas and their supply has proceeded as far as Tigray and Gondar.

Table 2 : Main crops produced in Wolmeraworeda (Ethiopian calendar)

Item	2003/04		2004/05		2005/06	
	Area	Qty	Area	Qty	Area	Qty
Wheat	10,222	302,199	11,349	394,946	12,666	519,302
Barley	7,905	173,271	9,148	301,884	9,440	339,979
Teff	7,835	110,225	6,334	110,225	8,962	210,607

Source: Wolmeraworeda Agricultural and Rural Development Office

In addition to cereal production, smallholders also practice vegetable and root crop production using rain fed and irrigation agriculture. Most of the farmers in the woreda practice potato production. According to the information from the woreda agriculture office, potato constitute around 65-70% of the area covered under vegetables. The other types of vegetables grown in the woreda include head cabbage, beetroot, carrot, kale, onion and tomato. The information from the woreda irrigation authority office indicates that farmers basically use irrigation mainly to produce these vegetables and root crops.

8.2 Design of the research project

8.2.1 Research Design

It is becoming increasingly popular that combinations of methods are to be employed in social research. It is usual for researchers to employ mixed method designs to investigate different aspects of the same phenomenon (Sarantakos, 1998). Data for this study were collected from both primary and secondary sources. Secondary sources were mainly published and unpublished sources, such as annual reports of the cooperative office of the Woreda, and literature review was also used to complement and refine the information that had been collected. On the other hand, the primary source included the socio-economic survey obtained by semi structured interview, with members of cooperatives, focus group discussions and field observations etc.

8.2.2 Samples and sampling techniques

The samples shall be drawn based on the design from the three kebeles. The participants in the sample are those households who are participating in house hold irrigation using a certain number of improved technologies. Hence, the sampling technique would tilt on purposive sampling as the number of participants in house hold irrigation with its full value chain is not that much inflated to take random or stratified samples.

8.2.3 Sample frame and sample size

The participants are selected from the three kebeles of wolmeraworeda where house hold irrigation with its full value chain is perceived to be implemented. The kebeles have an adequate source of water, farmers have access to research extension support from Holeta Agricultural center, the proximity of the woreda and kebeles to the capital city of the country

offers them the opportunity to get improved seeds, implements, pesticides and finally a better access to the vegetable market.

Based on this, a total of 108 farmers would be selected, 30 from each kebele. In addition, 9 members of primary cooperatives leaders; 3 from each kebele and 9woreda office staff 3 from each kebele would be communicated .

Table 3- Farmers' sampling distribution

Ser.No.	Names of Kebeles	No. of projects	No. of Kebeles	Samples Selected			
				Kebeles	P.CooperativeMembers	Woreda Staff	Total
I	II	III	IV	V	VI	VII	VIII
1	2	3	4	5			
1	Dhuffa	1	3	30	3	3	36
2	BerfeteTokoffa	1	3	30	3	3	36
3	Kore Oddo	1	3	30	3	3	36
	Total	3	9	90	9	9	108

8.3 Data collection: Tools and procedures

The method of data collection and analysis in social research depends on the nature of topic of research. To get the benefit of the outcome of using different tools a greater consideration has been given to the use of different tools to collect data and develop a near accurate understanding of the topic of research.

- The main tool of data collection here shall be the pre-coded questionnaire to collect information from farmers.
- A structured interview schedule shall also be used to collect information from Cooperative leaders and Development Agents.

The interview schedules shall contain mostly close ended questions,though some open ended and structured questions shall also be administered.

- In addition to the precoded questionnaires and interview schedule, case studies shall also be used as a tool of data collection. The case studies shall be of one individual house hold and one Woreda Working Group staff.
- For many issues on which data is difficult to be collected reliably through either by way of interview or questionnaires, non-participant observation or direct observation shall be the means to be resorted to.

10. Data processing

Quantitative raw data collected using questionnaires shall be organized and pre-processing test shall be carried out right after the field data collection is completed, and data shall be arranged categorically. Questionnaires shall be coded by kebele to facilitate analysis of questions on which respondents require to specify their opinions and to facilitate analysis of the open ended questionnaire. Responses on these questions shall carefully be collected and summarized. Outputs shall be categorized into different components relating to relevant variables for convenience in analyzing the findings.

Qualitative data collected through interviews, focus group discussions and observations

Shall be arranged into different categorical variables. Major themes shall be identified and analyzed inline with research questions and shall be summarized for use in descriptive analysis.

Issues intended to be addressed by the research shall beanalysed using findings from both quantitative and qualitative surveys applying triangulation method.

Survey findings are used to draw arguments on relevant issues and data from secondary sources and to draw conclusions and recommendations. The completed interviewschedules shall be scrutinized, verified, edited and arranged serially for coding. Three master code sheets shall be prepared; one for data collected from the households, anotherfor data collected at the grass root level leaders and the third for data collected from theWoreda staff.

11. Chapterization

Chapter one

The first chapter shall be on introduction to the subject matter of the present study. In this chapter an attempt shall be made to describe the concept of the role of House Hold irrigation Technologies on the lives of the users of these technologies.

Chapter Two

This chapter shall focus on a brief discussion on the review of earlier studies on the role of house Hold irrigation and its impact on the lives of small holder households.

Chapter Three

This chapter shall deal with the conceptual frame work and research design of the present study andshall explain the social and economic profile of the samples chosen for the present study

Chapter four

Deals with **the extent of** the use of modern agricultural inputs, by participants in House Hold Irrigation and the research questions areenlightened

Chapter five

This chapter shall provide the main findings of the present study and some workable suggestions for maximizing the benefits of small holder farmers and also recommendations for furthering the present study by identifying gaps observed while the conduction of this research.

Annex

Table 4. Time Estimate for the research

No	Research activity	Time required
1.	Identification of Problem	3 weeks
2.	Review of literature	3 weeks
3.	Writing the proposal	6 weeks
4.	Selection of research design	2 week
5.	Selection of respondents/Samples	2 weeks
6.	Preparation of tools of Data collection	1 week
7.	Training enumerators	1 week
8.	Pretesting of tools of data collection	1 week

9.	Data collection	6 weeks
10.	Data analysis and preliminary draft report	2 weeks
11.	Circulation of draft for comment	2 weeks
12.	Writing of report	4 weeks
13.	Presentation of report (Typing binding etc)	4 weeks

Table 5. Budget Estimate

No	Research activities	No. of personnel required	Duration	Cost (in Birr)	Remark
1	Perdium for data collector (100 birr per day)	5	20 days	10,000	
2	Perdium for research assistant (70 birr per day)	3	20 days	4,200	
3	Supervisor (Birr 500 per day including transport)	1	06 days	3,000	
4	Transport	10	200	2,000	
5	Stationery, typing, printing & binding			3,000	
Total				22,200	

Curriculum vitae

Bio data	Name: MulugetaTaye Nationality: Ethiopian Sex and Marital Status: Male and Married
Address	Addis Ababa, Zone/subcity: Nefasilk/Lafto – Woreda 01 P.o.box 23352 Mobile: 0911-345728 Gmail:mulutaye45@gmail.com
Expertise	Environment,rural development, food systems, water nich, irrigation, coffee, tea, vegetables, fruits and spices production and marketing, tuber and root crops, seed production, home gardening, postharvest handling, seed system,food systems, honey production and marketing, biodiversity, food security and livelihood,
Education	a. PhD degree in Ecology and Resource Conservation, Wageningen University, the Netherlands b. Master of science degree in Agriculture (Horticulture), Alemaya University of Agriculture c. Bachelor of science degree in Agriculture (Plant science), Addis Ababa University: AlemayaCollege of Agriculture, Ethiopia
Academic rank	PhD, Associate Professor

Trainings(diploma, certificate)	• Horticulture production, processing and protection technology, Awassa junior college of agriculture • Participatory Rural appraisal (PRA) Training (FARM AFRICA-Ethiopia), • Championship for change leadership training on food security, Kenya (Nairobi), (organizers: USAID and CAADP • International potato course: production, storage and seed technology , the Netherlands, • Recent development in potato technology for rural development in sub-Saharan Africa, • Action research programme on the improvement of peeper production SOS-Sahel • Applying Innovation System Concept in Agricultural Research for Development (Haramaya University
Employment and related experience	Educator and Researcher at Hawassa University, College of Agriculture (over 25 years), St Mary's University and Hope College of Business, Science and Technology(over four years)

Academic experience

Thought several courses onproduction, processing and marketing of vegetable crops, temperate and tropical fruit crops, root and tuber crops, coffee and tea, spices and herbs, research methodology,post harvest handling, seeds and seed production, landscaping, environment, rural development, food security, livelihood and rural development

Thesis research advising

Advising over two hundred master students on development, food security, livelihood, microfinance, irrigation, cooperative, honey production and marketing, production, processing, quality and marketing of vegetables, tropical and temperate fruit crops, coffee, tea and spices; cassava production and cyanide, at Hwassa University, St Mary's University, and Addis Ababa University.

Consultancy experiences

Consulted several national and international institutions/organizations in several subjects, which someof them are:

- At **ILRI and African RISE:** an assessment on highland fruit crops and vegetable productionunder the title: **Understanding production and marketing constraints of vegetables and fruit crops across the value chain in the Ethiopian highlands: case study at Sianna, Mahoney and Debreberhan.** **S**upervisor Dr Tilahun Amede ICRISAT-Principal Scientist and Country Representatives, Tel :251-911230135, (in the year 2014)
- **CIP andUSAID project:**Evaluating the potato and sweet potato programs in north and south Ethiopia with **HEDBEZ Business and Consultancy PLC.** Project title:**Tackling food insecurity and malnutrition through diversification: exploiting the potential of potato and sweet potato to reduce food insecurity and dependence on cereal in SNNPR and Tigray**(in the year 2014).
- With **SOS/SAHEL/**Ethiopia- Establishing peeper value chain project in south region particularly in Gurage area.An action research program financed by smallholder livelihood Improvement project(SLIP of SOS/SAHEL).

- With **SOS/SAHEL**/Ethiopia- Establishingan extension manual on pepper production and processing. Financed by smallholder livelihood Improvement project(SLIP of SOS/SAHEL).

- With **Dryland Coordination Group (DCG- Norway):** Consulting a project entitled : Contributing to wealth creation and food safety to farmers by reducing yield loss and mycotoxin contaminations of ground nut in selected drylands of Ethiopia".

- With **Dryland Coordination Group (DCG- Norway):** reviewing, and compiling a report entitled "Impact of Resettlement on the Livelihood, Food Security and Natural Resource Utilization in Ethiopia"

Engaged in several out-reach and community services, which

include:

- Several communities in Sidama/Hawassa, Woliyta on the production and protection of root and tuber crops: potato,*Plectranthusedulis,*enset, cassava, yam,

- Several farming communities on the production of groundnut in Eastern and Southern Ethiopia with the Dryland Coordination Group/ Norwegian Church Aid

- Several farming communities on the value Chain of pepper with SOS/Sahel at Hawassa/Sidama, and Gurage zone/Butagera,

- On the production of apple and olive crops at Debreberhan

Engagement with the farming community

- Studies on agronomy and crop physiology of *Plectranthsedulis* (Vatke) Agnew",

esearch Project leading

- Study on the growing and utilization of cassava plant, and its anti-nutritional factor: cyanide,
- Tilahun Amede and Mulugeta Taye. 2015. Home garden assessment: System niches, production and marketing constraints and intensification barriers in the Ethiopian highlands, africa-rising.net , ICRISAT.

Publications:

- MulugetaTaye, Lommen, W.J.M. ,Struik, P.C.(2013) Seasonal light interception, radiation use efficiency, growth and tuber production of the tuber crop *Plectranthusedulis*. European Journal of Agronomy 45:p. 153 - 164.
- MulugetaTaye, Lommen, W.J.M. ,Struik, P.C.(2012). Ontogeny of the tuber crop *Plectranthusedulis* (Lamiaceae) African Journal of Agricultural ResearchVol. 7(30), pp. 4236-4249
- MulugetaTaye, Lommen, W.J.M. ,Struik, P.C. (2012).Effects of breaking seed tubers on yield components of the tuber crop *Plectranthusedulis*. Journal of Agricultural Science, Cambridge pp 1-13
- MotiJaleta, Adugna Tolera, AnshaMotiJaleta, Mekonnen Yohannes, Adugna Tolera, Mitiku Haile, AnshaYesufe, KindeyaGeberehiwot, KelemeworkTafere, Yemane Gegziabher, and MekonnenTeferi, NigatuRegassa, Mulugeta Taye, Abiye Alemu and KirosMelesYesufe. 2011. Impact of Resettlement on the Livelihood, Food Security and Natural Resource Utilization in Ethiopia, GCOZA, Rapport No.65. Dryland Coordination group, Norway
- MulugetaTaye, Lommen, W.J.M. ,Struik, P.C. (2011).Effects of shoot tipping on development and yield of the tuber crop *Plectranthusedulis*. Journal of Agricultural Science, Cambridge, 150:484-494.
- MulugetaTaye, Lommen, W.J.M. ,Struik, P.C. (2007). Indigenous multiplication and production practices for the tuber crop, *Plectranthusedulis* in Chencha and Wolaita, southern Ethiopia. Experimental Agriculture, 43: 381-400
- GulelatDessie and MulugetaTaye (2001) Microbial load and microflora of cassava (*Manihotesculenta,*Crantz) and effect of cassava juice on some food borne pathogens. The Journal of Food Technology in Africa, Vol. 6,
- No. 1, , pp. 21-24

Teaching material

- MulugetaTaye (2000) Some quality changes during storage of cassava roots. The Journal of Food Technology in Africa, 5 (2): 64-66.
- MulugetaTaye, and EskindirBiratu (1999).Effect of storage and utilization methods on the total cyanide content of two cassava cultivars. SINET, Ethiopian Journal of Sciences, 22(1) 55-656.

Reading materials

- Alemayehu Chala, Berhanu Abate, Mulugeta Taye, Abdi Mohammed, Tameru Alemu and Helge Skinnes..2014. (DCG Report No. 74). Opportunities and constraints of groundnut production in selected drylands of Ethiopia , Dryland coordination group, Norway
- Mulugeta T., Girma T., Lideta S., Shimeles A., Waga M., Kebede A., (2011) Peeper production, post harvest and marketing, Manual. (with the help of SOS—SAHEL
- MulugetaTaye (2000). Principles and Practices of Coffee and Tea production. Hawassa University, Institute of Plant and Horticultural Sciences.
- MulugetaTaye(2010) Spices and herbs production and management, HawassaUniversity,College of Agriculture
- Mulugeta Taye (2010)Fruit crops production and management, Hawassa University, College of Agriculture
- MulugetaTaye (2009)Root and tuber crops production, Hawassa University, College of Agriculture

Experience as manuscript and reviewer

Editor : International journal of biodiversity and

conservation, India

Journal of Agriculture and Development, Ethiopia

Reviewer: African journal of agricultural research, Uganda

Reference

1. Dr Tilahun Amede ICRISAT-Principal Scientist and Country Representative ,
   Tel:251-911230135,

2. Dr Berhanu Abate, Hawassa University,
   Tel:0912-101792

   E mailberhanuabate@yahoo.com

3. DrFirduAzerefegn, Hawassa University
   Tel:0911876563