Mekelle University

College of Business and Economics

Department of Management

Contribution of Small Holders' Irrigation to Households Income and Food Security: A Case Study of Gum-selasa and Shilena Irrigation Schemes, Hintalowejerat, South-Estern Zone of Tigray, Ethiopia

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ID-CBE/PE 053/03

A Thesis Submitted to the Department of Management in Partial Fulfillment of the Requirements for the Award of Master of Arts Degree in Development Studies (Regional and Local Development Studies).

Advisor – Ato Tesfay Aregawi (Assistant Professor)

February, 2014
Mekelle, Ethiopia

Declaration

I Tedros Tsehaye declare that the thesis entitled "**Contribution of Small Holders' Irrigation to Households Income and Food Security A Case Study of Gum-selasa and Shilena Irrigation Schemes, Hintalowejerat, South-Estern Zone of Tigray, Ethiopia"** is the outcome of my own effort study and that all sources of materials used for the study have been properly acknowledge. I have produced independently except for the guidance in suggestion of the Research Advisor. This study has not been submitted for any degree in this University or any other University. It is offered for partial fulfillment of the requirement for the award of Masters Degree in Development studies with specialization in regional and local development.

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Certification

This is to certify that this thesis entitled **Contribution of Small Holders' Irrigation to Households Income and Food Security A Case Study of Gum-selasa and Shilena Irrigation Schemes, Hintalowejerat, South-Estern Zone of Tigray, Ethiopia"** Submitted in partial fulfillment of the requirement for the award of the Masters Degree on Development studies specialized in Regional and Local Development Studies to the college of Business and Economics, Mekelle University, through the Department of Management, done by Mr. Tedros Tsehaye ID. No. CBE/PE 053/03 is carried out by him under our guidance.

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Acknowledgements

First and for most, I would like to extend my unshared thanks to the almighty God for providing me the opportunity for what I have achieved.

I extend my deepest gratitude to my university advisor, Ato Tesfay Aregawi (Assistance Proffessor), whose intellectual advice, guidance and regular discussions were very valuable and inspiring in the process of the proposal writing, research undertaking and thesis writing.

I would also extend my deepest gratitude to the Woreda Hintalo-Wojerat Agriculture and Rural Development Office, Tigray Agriculture and Rural Development Bureau , Tigray Water Resources and Mines and Energy Bureau ,Tigray Finance and Economic Development Bureau and also thank the development agents in Gum-selasa and Shilena SSI, for their unreserved cooperation and facilitation in primary data collection.

I also sincerely recognize the contribution of farmers of Tabia Ara and Frewoyni for their hospitality and patience to answer my long research questions.

My special appreciation goes to my brother Yergalem Nega (Tigray Agriculture and Rural Development Bureau) for his time and effort in proof reading of my work, thoughtful comments, suggestions and discussions which highly contributed to the improvement of the content of my thesis. I also extend my heartfelt thanks to all my friends for their continuous advice and material support.

Acronyms and Abbreviations

ADLI	___ Agricultural Development Led-Industrialization
BOARD	___ Bureau of Agriculture and Rural Development
BOFED	___ Bureau of Finance and Economic Development
CSA	___ Central Statistics Agency
FAO	___ Food and Agricultural organization
FGD	___ Focus Group Discussion
GDP	___ Gross Domestic Product
Ha	___ Hectare
HH	___ Households
IWUAS	___ Irrigation Water Users Associations
MoA	___ Ministry of Agriculture
MoWRD	___ Ministry of Water Resources Development
NMTIP	___ National Medium-Term Investment Program
NGO	___ Non Governmental Organization
NAPAD	___ New African Partnership for Africa's Development
Qt	___ Quintal
REST	___ Relief Society of Tigray
SSA	___ Sub-Saharan Africa
SSI	___ Small Scale Irrigation
WoARDO	___ Woreda Agriculture and Rural Development Office
WSDP	___ Water Sector Development Program

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Definition of key Concepts and Terminologies

A household -was defined as a number of people living and eating together in the same dwelling and share the same income.

Cash crop -refers to vegetable crops produced through irrigation for the purpose of market to increase household cash income.

Food Security- is defined as a situation in which all house hold have both physical and economic access to adequate food for all members and where households are not at risk of losing such access and a situation in which people do not live in hunger or fear of starvation.

Irrigation- is the supply of water to agricultural crops by artificial means where rain fall is not adequate to support agricultural production FAO (2003).

Irrigation Development - Irrigation development could be defined as a case of agricultural development in which technology intervenes to provide control for the soil moisture regimes in the crop root zone in order to achieve a high standard of continuous cropping (EVDSA, 1996).

Small-Scale Irrigation- There are different criteria's for the classification of irrigation schemes around the world. The main criteria's frequently used for the classification of irrigation schemes are the irrigated area, scale of operation and management types. The most commonly used classification is small, medium and large scale irrigation schemes, though the interpretation of these categories may vary from country to country. In Ethiopia, irrigation schemes are categorized into three types based on size into small-scale (<200 ha), medium scale (200-3000 ha) and large scale (>3000 ha) (Rahemeto, 1999).

Abstract

The objective of this study is to assess the contribution of smallholders' irrigation to farm household's production and income with special reference to Gum-selasa and Shilena irrigation systems (schemes) in Hintalowejerat Woreda of south-eastern zone of Tigray Region. Both irrigation systems (schemes) are located in the arid and drought-prone areas where crop failure is a recurrent phenomenon due to insufficient and erratic rainfall.

The study has focused on examining the income contribution of irrigated agriculture on farm households who are using dam water for irrigation. In order to undertake this research both qualitative and quantitative methods were employed.

Qualitative method is used to capture data pertaining local perception and opinions on the contribution of irrigation to household income using focus group discussion and key informant interview. Quantitative data on households' resource ownership, income status, food security status, demographic characteristics and other basic data were collected from sample households using semi-structured questionnaire. Sample household heads were selected from the prepared list of irrigator household heads in both study areas through the lottery method.

Findings of this study show that smallholder irrigations is very important especially in those areas where insufficient and erratic rainfall is a recurrent phenomenon as a result rain fed agricultural production is not a dependable enterprise. For instance, of the available income sources, the average household income obtained from irrigation cultivation constituted 71.5%, 74.4% and 76 % during the three years period (2011-2013) in Gum-selasa.

In Shilena, the average household income obtained from irrigation cultivation was 70.2% 74.73% and 78% as compared to other sources of income respectively (2011-2013).

The study also revealed that the major challenges that inhibit the optimal utilization of the irrigation schemes or problems affecting irrigation performance (income) are lack of storage facilities, lack of market information and low price for cash crop produce during the harvesting period.

Based on the results of the study the researcher recommended the following: these are, improving the marketing system, ensure faire price for agricultural inputs and Provision of storage facilities in order to empower the irrigator farm households in price decision.

CHAPTER ONE: Introduction

1.1 Background of the Study

Agriculture contributes substantial share to the GDP of many low-income countries. It is often the leading sector of the economy as source of income, employment and foreign exchange.

In Ethiopia agriculture employs more than 70 percent and contributes 41 percent of the gross domestic product (MoFED 2010). More than half of the production of less developed countries gets their food from own-production. Agricultural outputs also are used as an input for industries so it can stimulate the growth of industrialization. Improving agricultural productivity contributes to income growth (UNDP 2007).

Significant agricultural growth cannot be achieved without appropriate policies. There is no unique policy prescription that fits the diversity of the agricultural sector in the less developed countries. Enhancing productivity is a common essential requirement. The increase in productivity will determine by the appropriate policy mix. The major lesson that emerges from country experiences is that to facilitate irrigated agriculture a number of factors need to be addressed in the rural sector such as infrastructure, social services, technology, marketing infrastructure, and seasonal credit availability, along with the building of an appropriate institutional environment (UNDP 2007).

Irrigation plays a key role in the performance of agriculture, which increases income growth. Income growth is essential for economic growth (Hussain and Biltonen 2001).

Ethiopia ranks 173 out of 187 the poorest countries on the Human Development Index (UNDP, 2013). Its GDP per capita was $ 350 in 2010 compared to $ 809 for Kenya and $ 1,705 for Sudan (IMF 2011).According to the growth and transformation document, 41% of Ethiopia's GDP depends on agricultural activity. Thus, the economy of Ethiopia is largely dependent on agriculture, and about 85% of the population is engaged in it.

Irrigation is a key driver behind growth in agricultural productivity and increasing household income which highlights the various ways that irrigation could have an impact on poverty. According to Lipton et al. (2004: cited by Haile 2008), there are four interrelated mechanisms by which irrigated agriculture can reduce poverty: (i) increasing production and income, and

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

In Ethiopia, agricultural production is primarily rain fed. It depends on erratic and often insufficient rainfall. As a result, there are frequent failures of agricultural production.

Irrigation has the potential to stabilize agricultural production and mitigate the negative impacts of variable or insufficient rainfall. Irrigation development also can help offset some of the negative effects of rapid population growth (2.6% per year in Ethiopia; CSA 2007).

Irrigation use in Ethiopia dates back several centuries, and continues to be an integral part of Ethiopian agriculture. In Ethiopia, modern irrigation began in the 1950s through private and government owned schemes in the middle Awash valley where big sugar, fruit and cotton state farms are found (FAO 1997).

The main purpose of irrigation development in the 1960s was to provide industrial crops to the growing agro-industries in the country. The agro-industries were established by foreign investors and had the objective of increasing export earnings. During the 1960s, irrigation was seen as part of the modernization of the country's agricultural economy. It was considered as an important investment for improving rural income through the increased agricultural production. But, in 1975 rural land proclamation was issued. Following the rural land proclamation, the irrigated private farms were nationalized and converted to state farms by the Derg regime.

The current government has undertaken various activities to expand irrigation in the country.

The country’s strategy Agricultural Development Led Industrialization (ADLI) considers irrigation development as a key input for sustainable development. Thus, irrigation development, particularly small-scale irrigation is planned to be accelerated (MOFED, 2010).

Ethiopia is believed to have the potential of 5.1 million hectares of land that can be developed for irrigation through pump, gravity, pressure, underground water, water harvesting and other mechanisms (MOFED, 2010).

In line with the development policy of the country, the Regional Government of Tigray is promoting irrigation development so as to increase and stabilize food production in the region. According to BOARD (2013) report, the total area cultivated for irrigation in 2013 was 149,205 hectares and its production 21,261,859 quintals with 392,687 beneficiaries.

The highest irrigation land was in woreda Ahferom and the lowest in woreda Erob. The highest number of production by irrigation in 2013 was found in woreda Kilite Awlaelo, Medebay zana and Mereb leke while low production was in most part of the western zone, Woreda Erob, Ganta Afesum, Raya Azebo, Ofla and Raya Alemata (BOFED, 2013).

The study area Hintalo Wojerat is endowed with considerable and diverse natural resources, with capacity to grow diverse annual crops. The altitude ranges from 1774 to 2061m masl.

The mean annual rainfall is 596 mm and ranges from 471.5 to 636 mm (WoARD, 2011).
Therefore, the wereda has a great potential for small-scale irrigation. According to WoARDO for HintaloWojerat, in 2011 a total of 4,059.58 hectares of land was covered with irrigation (irrigated) and a total of 222,085.13 Quintal of production benefiting 13, 298 Households. Therefore the objective of this study is to assess the contribution of small-scale irrigation schemes to household income.

1.2 Statement of the problem

In Ethiopia, most settlement areas are degraded, per capita land availability is dwindled and productivity of land and labour are reduced and agricultural production is also affected by variability of rainfall and drought (Seleshi et al, 2007). As a result, low farm production, widespread poverty, poor health, etc; remain to be endemic problems in Ethiopia (Pendon, 2007). All these situations expose the country to exacerbate the problem of poverty. On the other hand, irrigation and water management practice could provide opportunities to cope with the problem of rainfall variability, enhance productivity per unit of land, and increase the volume of

annual production significantly. More to the point, irrigation development benefits the poor households by promoting the production of high value crops, generation of farm and off farm income opportunities and plays critical role in achieving household food security (Cornic et. al, 2003 cited in Azemer, 2006 and Mengistu, 2008).

Irrigation increases agricultural productivity and farm income per ha, according to previous studies (Nhundu et al., 2010; Gebremedhin and Peden 2002; Hussain 2006). It insulates the national agricultural economic sector against weather-related shocks and provides a more stable basis for economic growth and poverty reduction. It supports the process of transforming subsistence agriculture in to market-oriented production of high value crops (Asfaw 2007).

The development of water resources for irrigated agricultural purposes is rising rapidly. According to BCEOM (1998) and Tilahun & Paulos (2004) as cited in Awulachew et al. (2010), in 1990 Ethiopia had an estimated total of 161,000 hectares of irrigated agriculture, of which 64,000 ha were in small-scale schemes, 97,000 ha were in medium-and large-scale schemes and approximately 38,000 ha were under implementation. This had grown to more than 247,000 ha by 2004, with traditional irrigation schemes alone covering more than 138,000 ha. Currently, the Ethiopian government gives more emphasis to small-scale irrigation as a means of increasing household production and income (MOFED 2010). Therefore; the national regional state of Tigray gives emphasis to small scale irrigation as a means of expanding irrigated agriculture to increase farm household production.

Like other parts of the country; Tigray is one of those with high irrigation potential areas in the country and as a result, irrigation vegetable and crop production is becoming a means to increase food production in the region (Alem, 2008). Hence in line with the development policy of the country, the Regional Government of Tigray is promoting irrigation development so as to increase and stabilize food production in the region.

According to reports of Tigray Regional Agricultural and Rural Development Bureau , in 2011 total of 104,256.75 hectares of land was irrigated and 9,570,456.75 quintal of production

benefiting 392,687 households. In 2012 also total of 149,204.7 hectares of land was irrigated and 21,261,859 quintal of production benefiting 479,169 Households. (BOARD).

Wereda Hintalo Wejerat is found in the South- eastern zone of Tigray where insufficient and erratic rainfall is a recurrent phenomenon that causes crop failure. It is one of the chronically food insecure areas in Tigray Regional State and is among the 31 vulnerable districts that are targeted by the Regional food Security programs (BoARD). The district has been repeatedly hit by drought due to the insufficient and erratic nature of rainfall. In this respect, water use for agriculture by smallholder farmers is an appropriate choice. According to HintaloWojerat Wereda Agricultural and Rural Development Office, in 2011 total of 4,059 .58 hectares of land was irrigated and 225,085.13 quintal of production benefiting 13,298 Households. In 2012 total of 5,501 hectares of land is irrigated and 508,451 quintal of production benefiting 18,221 Households. Therefore, the researcher is interested to see the implication of irrigation whether it helped to curve the consequences of drought and its contribution to household income.

1.3. Research Questions

The main research question is "What is the contribution of small-scale irrigation agriculture to households' Production and income?

Specific research questions to be answered by this are following

1. What is the contribution of small-scale irrigation agriculture to increase agricultural production and household income?
2. What factors do promote or hinder small scale irrigation?
3. What are the major field crops and vegetables grown using small scale irrigation in the study area?
4. What is the role of small-scale irrigation agriculture in improving farm households' food security?

1.4. Objective of the Study

General Objective

The overall objective of this study is to assess the contribution of small -scale irrigation agriculture to households' Production and income in HintaloWojerat Woreda of the South-Estern Zone of Tigray.

Specific objectives of the study

1. To assess the contribution of small-scale irrigation agriculture towards increasing agricultural production and household income.
2. To investigate the factors that promote or hinder small scale irrigation in the study area.
3. To identify the major field crops and vegetables grown using small scale irrigation in the study area.
4. To assess the role of small-scale irrigation agriculture in improving households food security.

1.5. Scope and Limitation of the study

Conceptual Scope-This study was assessed the contribution of small-scale irrigation to farm households income based on the interlink age of access to irrigation, production, income employment and food security.

Methodological Scope- 120 sample household heads were selected by lottery method from the household lists prepared in both study area to analyze and to give conclusions and recommendations. It focused on household heads those who have using irrigation for agricultural production from dam water.

Geographical Scope- The study has been conducted in Woreda Hintalo- Wejerat, in the selected sample areas of Gum-selasa and Shilena Small-Scale Irrigation Schemes.Temporal or Time Scope-Time series data (from 2011-2013) was employed and the study was completed within six months.

The following conditions can be considered as a limitation of the study. This study is limited to assess the contribution of small scale irrigation on gross income; however, the net income analysis of irrigation is not assessed. As compared to the study population of 579 irrigation households, the sample household limited to 120 may affect the degree of representation. There are twenty two irrigation schemes in the district; however, due to limited resources (budget, time, and facilities) the study was limited to only two irrigation project sites.The study is also limited to only irrigator farm household heads.

Even though both qualitative and quantitative research methods are employed to triangulate the findings, there might still be some irrigator farm households that understate income or produce.

1.6. Significance of the study

Conducting the study would have the following contributions.

· It contributes to the theoretical and empirical body of knowledge available on irrigation development for Farm Production and household income.

· Moreover, it will serve as a spring board for further research on the issue.

·The result of the study will help local authorities and development agents to formulate appropriate intervention mechanism.

1.7. Organization of the study

This thesis is organized in to five chapters. The first chapter comprises the introduction part of the research consisting of statement of the problem, research questions, objectives of the study, scope and limitation of the study and significance of the study. The second chapter is overview of the literature deals with different concepts and definitions. The third chapter provides methodology of the research which consists of site selection and description of the study area, nature and sources of data, research strategy and design, sampling technique and sample size determination, data collection method, and data processing and analysis. Chapter four presents the study results and discussion part of the research, and finally summary, conclusion and recommendation are presented in chapter five.

CHAPTER TWO: Literature Review

2.1 Nature of Smallholder Agriculture

In order to describe the nature of smallholder agriculture one needs to have a good understanding of who the smallholder farmer is. Consequently, this section attempts to provide a definition of smallholder farmers and relies heavily on (Machethe and Molle, 2000). Despite widespread reference to the smallholder farmer in the literature on agricultural and rural development, few analysts attempt to define or describe the smallholder farmer Possible reasons for this include (a) the difficulty in defining the smallholder farmer, (b) assumption that everybody knows who the smallholder farmer is: (c) argument that there is no need for a precise definition of a smallholder farmer; and (d) acknowledgment that "smallholder farmer" means different things depending on the country one is looking at and, therefore, no single definition would suffice.

Various terms are used in the literature to describe smallholder farmers. These include "small scale farmers", "resource-poor farmers", "subsistence farmers", 'peasant farmers", "food-deficit farmers", "household food security farmers", "land reform beneficiaries" and "emerging farmers".

The main criteria often used to classify farmers as smallholder farmers by various analysts includes

a) land size; (b) purpose of production, i.e whether for home consumption or market; (c) income level, i.e whether poor or rich, and, in South Africa, (d) racial group, i e whether one is white or black and. thus, historically advantaged or disadvantaged, respectively.

The following definitions of farmers have been used in South Africa:

• (Van Zyl et al 1991) classify farmers into three main categories, namely, commercial, emerging and subsistence farmers. Commercial farmers are defined to include those who operate in the market economy. Emerging farmers are those who cannot function (participate) in the market economy because of restrictions in the (economic) environment. Subsistence farmers include those who produce mainly for home consumption and produce surpluses by coincidence

• (Botha and Treurnicht, 1997) identify four categories of farmers fully commercial farmers, emerging commercial farmers, land reform beneficiaries and household food security farmers

• The Farmer Support Services Working Group Workshop (1997) identify categories of clients for extension as emerging farmers, land reform beneficiaries, subsistence farmers and

commercial farmers who are further subdivided into small, medium and large farmers. These categories of farmers are not defined

• (Catling and Saaiman, 1996) define a small-scale farmer or grower as a "historically disadvantaged individual or group having access to land which normally supports a small or medium agricultural enterprise."

(Eicher, 1990) identifies four types of farmers in Africa:

• Resource-poor farmers — these are farmers who sell some of their labour to large-scale farmers and engage in rural nonfarm activities to meet their food needs. They produce some of their food and buy the rest.

• Smallholders and herders - these rely mainly on family labour to produce food, livestock, and export crops for both domestic and international markets.

• Middle "progressive" farmers -- they own and operate their farms and can bear the risk of farm innovation, provide seasonal jobs, and generate a marketable surplus.

• Large-scale farmers -- these are farmers who produce mainly for the market, possess political power and are skilled in extracting subsidies and services from the state.

Until the early 1990s, it was generally accepted in South Africa that "commercial farmers" referred to white commercial farmers and "smallholder farmers" to black farmers in the former homelands However, the reality recently is that a number of blacks, albeit small, have graduated into the commercial farmer category. Therefore, it is no longer appropriate to consider all commercial farmers to be white.

• Resource-poor farmers — those whose sources of livelihood include farming and nonfarm activities and have total assets and annual income whose value does not exceed that of a household which would be considered as poor in terms of the country's criteria.

• Middle-income farmers — these are farmers whose main source of livelihood is farming and have total assets and annual income worth more than that of a poor household but not enough to be classified as rich.

Resource-poor farmers would include subsistence farmers (i.e. those who produce mainly for home consumption) and those with small gardens for fruits and/or vegetable cultivation.

Farming does not generate enough income for them to meet all their needs and, therefore, must engage in nonfarm activities to make ends meet these farmers cannot afford to pay for support services and rarely sell their produce. Also included in this category are those who derive their

livelihood mainly from nonfarm activities and engage in farming (e g gardening) to augment their nonfarm income Resource-poor farmers are generally risk-averse, rely mainly on family labour, own a few animals, and have a small piece of farmland- In addition, they face high transaction costs. Delgado (1998) argues that reducing these transaction costs will determine whether resource-poor farmers' access to assets, information, services and markets will increase Middle-income farmers include those who are richer than resource-poor farmers and farming is their main source of income. These farmers may also engage in nonfarm activities to augment their farm income they produce mainly for the market but do not have enough resources and technical expertise to increase their product market share.

They cannot compete effectively with large-scale commercial farmers Unlike resource-poor farmers, middle-income farmers are not risk-averse, often they are members of farmers' organizations, can raise some collateral for commercial bank loans and can contribute towards the cost of farmer support services.

2.2 Role of Smallholder Agriculture in Rural Development

Agriculture is an important source of income and livelihood for many rural households in developing countries Carter and May (1997) identify agricultural production as one of the most important sources of income for rural households in South Africa. (Eicher, 1999) notes that two-thirds of people in Africa derive their livelihood from agriculture. Smallholder agriculture is important to employment, human welfare, and political stability in Sub- Saharan Africa (Delgado, 1998) In addition, smallholder agriculture can moderate the rural exodus, create growth linkages and can enlarge the market for industrial goods (Eicher and Rukuni, 1996). Smallholder agriculture is also considered to be both a major cause of and potential solution for poverty reduction and economic growth (Jazairy et al., 1992 and DFID, 2002).

To maximize the contribution of smallholder agriculture to poverty reduction, agricultural productivity must be raised and sustained. This must occur in such a way that environmental sustainability is promoted. A misperception exists that there is always a trade-off between productivity and environmental sustainability and, therefore, the two cannot be pursued together. Productivity and environmental sustainability must be pursued together. (Reardon, 1998) notes that environmental sustainability emerged as a critical issue in African policy circles in the late

1980s because of famine, growing evidence of land degradation, deforestation, and desertification, and because of a rebirth of concern for the environment in developed countries.

2.3 Role of Smallholder Irrigation in Agricultural Development

Investing in smallholder irrigation is one of the most effective ways to develop smallholder agriculture and, thus, contribute to poverty alleviation. The contribution of irrigation to poverty alleviation has been demonstrated in countries such as Bangladesh where growth in public sector funded canal irrigation and private sector funded tube-well irrigation have played a major role (Shah, 1993).

Sally et al. (2003) conclude that smallholder agriculture intensification by improving the management and productivity of land and water in a sustainable manner is a solution for both poverty reduction and agricultural growth in sub-Saharan Africa Irrigation development benefits the rural poor in various ways including (a) reduced food prices resulting from increased production; and (b) increased on-farm and off-farm employment leading to income generation for the poor Thus, irrigation contributes to food security.

Smallholder irrigation schemes have not performed well in Africa. These schemes have performed poorly in terms of yields and economic returns (Barghouti and Le Moigne, 1990; Underhill, 1990).

The poor performance of smallholder irrigation schemes means that farmers have not been able to produce enough yields to match the demand for food. In order to match the demand for food, it will be necessary to increase productivity because the scope for increasing food production by increasing the area under cultivation is limited The growing scarcity of water will make it extremely difficult to expand food production by increasing the area under cultivation(Mehra and Esim ,1998) note the growing concern in the decline in the area under irrigation Some of the factors responsible for this include increased competition for the use of irrigation water for urban and industrial consumption, depletion of groundwater and other alternative water sources, and increased salinity Salinity has reduced the productivity of irrigated areas. (Postel,1996) estimates that more than ten percent of the worlds irrigated area may have enough salt build up to lower yields.

Water is scarce and it is important to use it efficiently and increase its productivity. The International Water Management Institute (2000) notes that there is scope for doubling the productivity of water in many cases Significant increases in water productivity may come from improved water management and improved plant varieties and agronomic practices. The unreliability of water supplies has contributed significantly to the poor performance of smallholder irrigation schemes in terms of productivity and profitability. The productivity of smallholder irrigation schemes can be increased by improving the reliability of water supplies.

The International Water Management Institute (2000) concludes that weak institutions are often to blame for poor reliability of water supplies. Therefore, improving water productivity by ensuring that water supplies are reliable will require the right mix of manageable technologies, the organizational skills necessary to use these technologies and appropriate incentives for farmers and water service providers.

2.4 Constraints on Smallholder Agriculture

Increasing smallholder agricultural productivity requires that smallholder farmers gain access to reliable and good quality farmer support services such as extension, finance and marketing.

Increasing smallholder agricultural productivity is particularly important in view of the increasing scarcity of land for cultivation which makes extensification an ineffective response to the demand for increased agricultural production. Thus, smallholder farmers should be assisted to produce more from the existing land because prospects for increasing agricultural production through land expansion are not good.

International experience indicates that with adequate access to farmer support services, smallholder farmers can increase productivity and production significantly For example, smallholder farmers in Zimbabwe (average farm size of between 2 and 3 hectares) doubled maize and cotton production in the 1980s when extension, marketing and credit services were provided (Rukuni and Eicher, 1994). Significant achievements have also been made by smallholder farmers in Southeast Asia although quantification of the impact of support services such as extension is rarely undertaken (Purcell, 1994), there is some evidence that extension has increased productivity and income (Birkhaeuser et al , 1991; Bindlish and Evenson. 1993; Bindhsh et al., 1993, Umali-Deininger. 1997).

Agricultural support services are important for successful land distribution. In addition to making land accessible to smallholder farmers through land reform, smallholder farmers must gain access to farmer support services and reliable markets to ensure that smallholder farming is profitable on a recurring basis (Eicher and Rukuni. 1996).

Improving access to support services may require that agricultural service organizations be transformed so that they can provide good quality services to smallholder farmers However, improving the performance of agricultural service organizations addresses only one of the prime movers of smallholder agricultural development and, therefore, not a sufficient condition for getting smallholder agriculture moving ,other prime movers are human capital, new technology, rural capital formation (infrastructure and improved livestock herds) and a favourable economic policy environment (Timmer, 1990; Eicher, 1990; Eicher and Rukuni, 1986).

According to New African Partnership for Africa's Development (2003). for African agriculture to be productive and profitable, the following challenges need to be addressed;

- Low effective demand for agricultural products due to poverty;
- Poor and un-remunerative external markets;
- Low level of investment due to risk arising from unfavorable climatic conditions;
- Limited access to technology and low rate of technology adoption:
- Low levels of investment in rural infrastructure resulting in high transaction costs; and
- Organizational weaknesses for service provision.

In addition to removing the above constraints, it will be necessary to improve the policy and regulatory framework for agriculture to encourage participation of local communities in rural areas and the private sector.

2.5 Irrigation Development and Food Security

The main cause of rural poverty is the fluctuation in the amount and distribution of rain fall (Regassa et al, 2006). Then to tackle the problem associated with the erratic nature of rainfall, alternatives should be sought to get dependable production from agriculture.

The issue for food security of many developing countries is of serious concern. Widespread denudation and accelerated soil erosion diminish the productivity of both cultivated and grazing rain fed lands. The problem of food security is exacerbated by the rapid growth of population and hence of the demand for food (FAO 1987).

Food security is defined as a situation in which all house hold have both physical and economic access to adequate food for all members and where households are not at risk of losing such access and a situation in which people do not live in hunger or fear of starvation. World-wide, around 852 million men and children are chronically hunger due to extreme poverty, while up to two billion people lack food security intermittently due to varying degrees of poverty (FAO, 1996b, 2003).

According to the world Bank ,food security is attained when all people at, all times have physical and economic access to sufficient, safe, and nutritious food to be healthy and active (WB, 1986).

According to the same source, to be food secured as identified by (Max well and Smith,1992) includes the following four conditions/ concepts, □

_ Sufficiency – the calories required for an active and healthy life

_ Security – the balance between vulnerability, risk and insurance

_ Access to food – through production, purchase, exchange or gift,

_ Time – where food insecurity can be chronic, transitory and cyclical (max well and smith, 1992).

Food self- sufficiency refers to a condition where productions of crops or livestock by households cover their annual food consumption requirement (Degefa, 2005). Bringing the concept into local context, attempts were made to differentiate self- sufficiency from food security.

According to Degefa (2005) self- sufficiency is a concept that deals more with availability, while food security in addition to food availability deals with issues such as access to utilization and security.

Many development writers underline the importance of irrigation as a viable strategy to raise crop yields and to achieve food security in these third world nations including Ethiopia where there is ample irrigation potential. This statement sounds convincing, because it is difficult to effectively utilize agriculture in developing counties in the face of water uncertainty and erratic rainfall distribution, unless we invest in water development. According to Rahmato (1999), investment on water management schemes will stabilize agricultural production and promote food security in areas of uncertainty and scarcer rainfall. Irrigation also makes possible agricultural intensification. In condition of low land- man ratio besides giving the chance of growing marketable crops.

Irrigation provides the means of maximizing production with multiple cropping taking the advantages of modern technologies and high yielding crop varieties (Seid, 2002).

In summarizing, as already revealed in the previous sections, irrigation is a vital tool to achieve food security through increasing agricultural products, intensifying the cropping patterns, increasing income by producing high value crops and protecting soil in developing countries where agriculture takes the lion's share of their economy.

2.6 Empirical Review on Irrigation in Ethiopia

Irrigation is categorized as small, medium or large-scale depending on the area irrigated, scale of operation and type of control or management. But the criteria for this category may vary from country to country. For example, in India the irrigation scheme of 10000 ha. is classified as small while in Ghana the largest irrigation is 300 ha. (Smith, 1998).

The three-scale classification of irrigation was established in Ethiopia during the Derg regime (Dessalegn, 1999). Accordingly, large-scale irrigation schemes are those, which hold over 3000 ha. of irrigation area while medium scale cover an area of 200-3000 ha.

Small-scale irrigation schemes involve those with the total area of up to 200 ha. According to Woldeab (2003), the practice of small scale irrigation schemes operated by traditional methods have been passed down from antiquity. However, the importance of small irrigation development as a means for socioeconomic transformation has been considered since the Second World War Woldeab(2003).

The Ethiopian economy is dominated by smallholder subsistence agriculture, which accounts for 46% of the GDP, 85% of export commodities and 85% of the employment (Makombe et al., 2007). The majority of the sector depends on rainfall. Irrigation and improved agricultural water management provide opportunities to cope with the impact of climatic variability and to enhance productivity per unit of land and to increase the production volume. The irrigated area has increased rapidly: In 1995 it was 75,000 ha and in 2003 it had increased to 200,000 ha (Diao and Nin Pratt, 2007).

The history of modern irrigated agriculture in Ethiopia dates back to 1960 when it started with the production of industrial crops (sugar and cotton) on large-scale farms by private investors in the Awash area. However, local farmers had already been practicing traditional irrigation during the dry season using water from river diversions for subsistence crop production (Awulachew,

2006). Modern small-scale irrigation (SSI) development and management started in the 1970s initiated by the Ministry of Agriculture (MoA) in response to major droughts, which caused wide spread crop failures and food insecurity. After the rural land proclamation in 1975, the government nationalized the large irrigated farms and the small-scale-irrigation schemes were transformed into cooperatives. The government began to focus on the potential of small scale irrigation to improve food security and started promoting farmers and community based small-scale irrigation through giving assistance and support to adopt modern technologies, rehabilitation and upgrading of traditional schemes after major famines in 1984/1985 (Habtamu, 1990).

To reduce the risk of crop failure due to drought and erratic rain fall conditions in Ethiopia, the MoWR has prepared a National Medium-Term Investment Program (NMTIP) for Water Sector Development Program (WSDP) for 15 years (2002-2016) that include small-scale irrigation development as one of its main components to reduce dependency on rain fed production.

The current government has formulated a policy to develop a total of 274,612 hectare with in a period of 15 years from 2002 to 2016 under short, medium and long term emphasis, with the aim of improving food security and food self- sufficiency, nutritional status, contributing to the supply of industrial raw materials, improving rural employment opportunities (MoWR,2006).

The MoWR is implementing thirteen irrigation projects located in different parts of the country (Teshome, 2006), covering an area of 493,603 ha, which are expected to be completed before the end of the NMTIP in 2016.

Tadesse *et al*, (2004) conduct a study on the economic importance of irrigation in Donny and Bato Degaga small holder's irrigation schemes in the Awash Valley of Oromiya Regional state with the objective of investigating the impact of these irrigation schemes on food security and drawing lessons that can be learned from the success and failure of irrigation. As the result of the study indicated, the main cash crops produced were onion, tomato and pepper.

The production of irrigation agriculture highly increased irrigator's access to basic needs in those irrigation schemes. The finding indicated that the challenges of small-scale irrigation are; low fertilizer application, poor on-farm management, inequitable distribution of labour for the maintenance of irrigation canals, irrigation water loss, tendency of considering irrigation infrastructure as government's property and market problems.

The findings, further, indicate that irrigation can become a source of employment and income generation for the local people. More to the point, Gebrmedhin and Pender (2002) in their study of policies and institutions to enhance the impact of irrigation development in mixed crop livestock system in Ethiopia, disclosed that most problems of small- scale irrigated agriculture that hamper further development of this sub sector arise from its Operational method and not from its construction and design.

They pointed out that in Ethiopia; irrigation development planning gave emphasis to the agronomic, engineering and technical aspects of irrigation schemes, with little consideration to issues of management, beneficiary participation, availability of institutional support services such as credit, extension in-put supply and marketing.

Wagnew (2004) conducted a case study using a formal survey on socioeconomic and environmental impact assessment of four community based small-scale irrigation in the Upper Awash Basin of Ethiopia, concluded that rural credit system, institutional support, monitoring of irrigation schemes, training in water management, marketing and general crop production, empowerment of local communities, economic evaluation of optimal plot size, cropping patterns for agronomic practices and resources utilized in the irrigation schemes were necessary conditions for viable and sustainable irrigation schemes.

According to Girmay et al (2000) in their study on management and institutional considerations of small-scale irrigation in Tigray, the absence of proper understanding of economics of small-scale irrigation, difficulty in the provision of inputs services and technical advice, lack of efficient utilization of water resources, lack of viable product markets and marketing institutions were some of the reasons for low level of efficiency and lack of sustainability in small- scale irrigation schemes.

Azemer (2006) also studied food security and economic impact of irrigated agriculture in Teletle irrigation scheme of North Shoa Zone. The main objective of the study was to investigate the impact of small- scale irrigation on food security and economic status of the house hold. The finding of his study demonstrated better performance of irrigated agriculture in crop production and productivity than rain fed agriculture.

Use of irrigation also demonstrated a change in the livestock holding capacity of irrigators than pre-irrigation and it also signified that higher food availability, accessibility and better income in irrigators than non irrigation beneficiary households.

2.7 Conceptual and Theoretical Framework

Access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This, in turn, opens up new employment opportunities, both on-farm and off-farm, and can improve incomes, livelihoods, and the quality of life in rural areas. Overall, irrigation water, like land, can have an important income-generating function in agriculture specifically, and in rural settings in general.

There are five key dimensions of how access to good irrigation water contributes to socioeconomic uplift of rural communities and alleviates poverty. These are production, income and consumption, employment, food security, and other social impacts contributing to overall improved welfare. These poverty-reducing variables are interrelated. In general, access to good irrigation allows poor people to not only increase their production and incomes, but also enhances their opportunities to diversify their income base, and to reduce their vulnerability to the seasonality of agricultural production and external shocks. It should be noted that the poor also use water for other farm and non-farm production activities, particularly small-scale rural enterprises such as livestock rearing, fish production, brick making and so on.

Irrigation enables the poor and smallholders to achieve higher yields. The productivity of crops grown under irrigated conditions is often substantially higher than that of the same crops under unirrigated/rainfed conditions.

Higher productivity helps to increase returns to farmers' endowments of land and labor resources. Apart from yield improvements, higher productivity partly stems from higher land use intensity and cropping intensity. Irrigation affects cropping intensity positively (Dahawan and Datta, 1992).

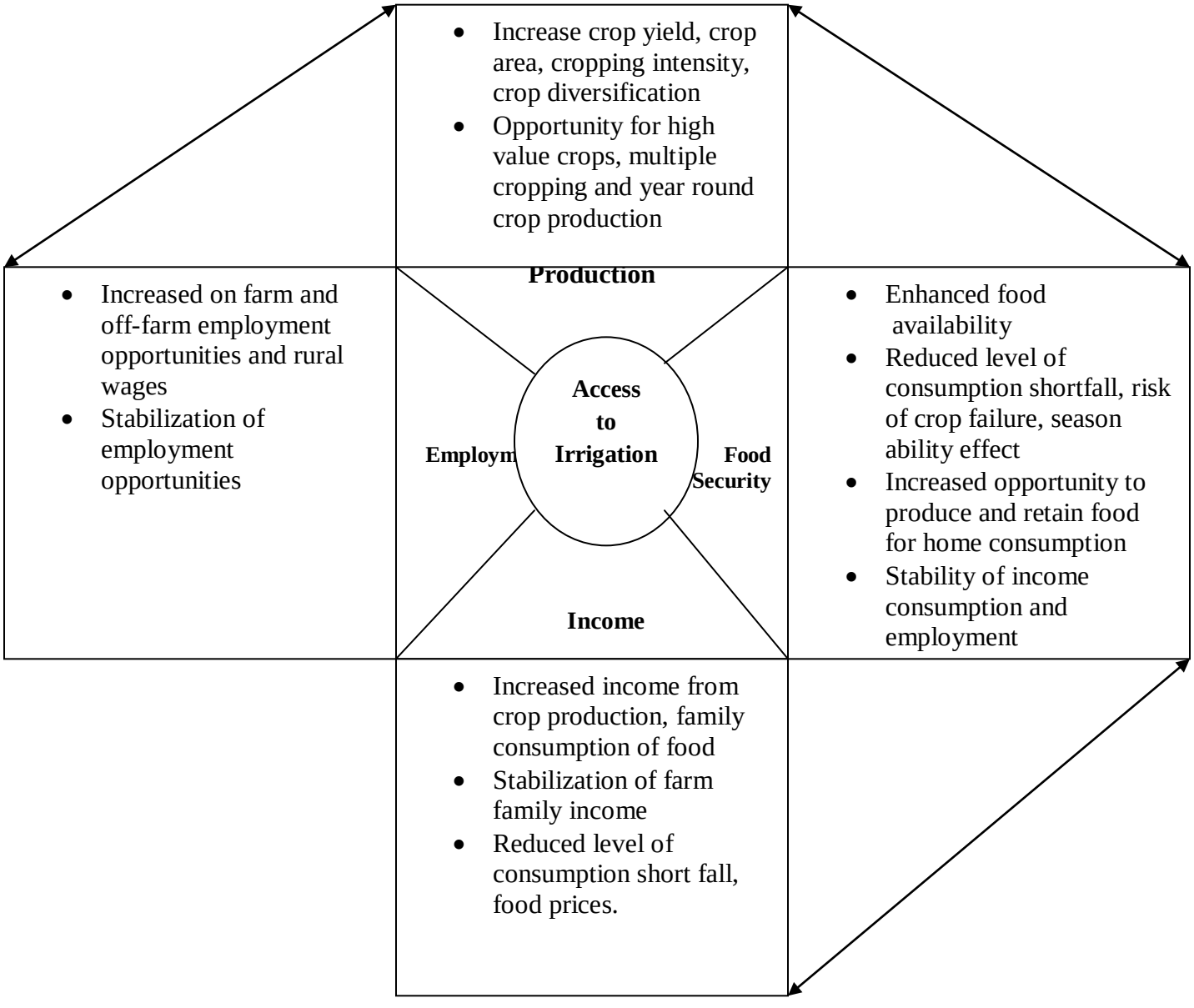
Access to good irrigation enables crop-switching: substituting low-yielding and low-profitable crops with new high-yielding and more profitable crops. Implicitly, this implies switching from subsistence production to market-oriented production.

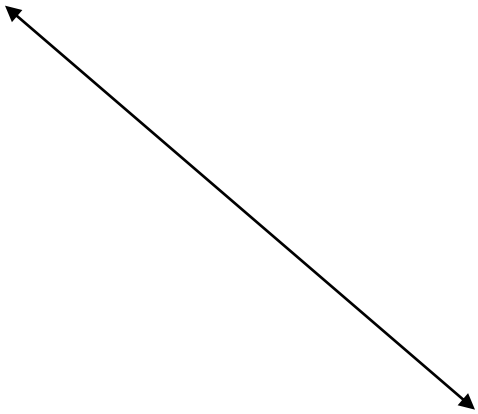
Further, crops can be grown year-round. Thus irrigation culminates in what is commonly known as crop diversification, and enables the poor and smallholders to spread risk more evenly over the course of a year (Reardon and Taylor, 1996). In fact, crop diversification is both an income maximization and risk minimization strategy.

Increased employment for the poor may originate from the labor-intensive nature of irrigation developments/ construction and subsequent maintenance, and from intensive cultivation both on their own farm, as well as on the farms of other large farmers who may find it difficult to provide extra labor from family resources during peak times. Additional employment opportunities may come from nonfarm activities generated through increased demand for inputs and increased supply of outputs.

Generally irrigation has positive impact on farm household income through enhancing agricultural performance, using inputs and high value crops that give rise to increase in production which in turn gives rise to household income and finally to poverty reduction.

Fig 2.1- Irrigation and Income, Production, Food Security and Employment Linkages.





Source: Hussian and Hanjra, 2004

CHAPTER THREE Research Methodology

3.1 Site Selection and Description of the study area

3.1.1 Site Selection

This research is basically a survey case study focused on two community-based small-scale irrigation systems, namely Gum-Selasa and Shilena SSI. The reason for the selection of these irrigation systems is that both are found in the semi-arid areas where insufficient and erratic rainfall is a recurrent phenomenon that causes crop failure. Accessibility of both irrigation systems is also another factor for their selection. Besides the wereda is also one of the high irrigation potential areas in the region.

In this respect, water use for agriculture by smallholder farmers is an appropriate choice. Therefore, the researcher was motivated to assess its contribution to household income.

3.1.2 Description of the study area

Tigray is one of the national regional states of Ethiopia which is located in the northern part of the country between 12015'N and 14057'N latitude and 36027'E and 39059'E longitude and covers an area of 53,000 square kilometres (Solomon 2005). The region is bounded by Eritrea to the North, the Sudan to the West, and the Ethiopian regions of Amhara and Afar to the South and the East respectively.

Tigray consists of seven administrative zones including Mekelle town which are further divided in to 34 rural districts and 12 town districts.

Mekelle is the capital city of the National Regional State of Tigray. Each district is subdivided into tabias and each tabia is divided into kushet. Thus, tabias are the lowest unit in the administrative hierarchy. The zones are the Western zone, North Western, Central, Eastern, Southern Eastern, Mekelle and Southern zone. The delineation is made based on natural boundaries like rivers, escarpments and mountain peaks; settlement, population size, agro ecology and convenience & proximity to administer centers (BOFED, 2004).

Tigray has a total population of 4, 316,988 (CSA, 2007) which is about 5.8% of the total population of Ethiopia.

The sex composition is 2,131,319(49%) male and 2,195,523(51%) female. 80.5% of the population lives in the rural areas (CSA, 2007). The economically active age group accounts about 51.8% of the total population. In terms of religion 95.6% of the population are orthodox Christians, 3.96% are Muslims, 0.36% are Catholics and 0.08% are Protestants (CSA, 2007).

Regarding ethnic composition, 96.54% are Tigraway, 0.2% Agew, 0.7% Erob and 0.07% Kunama and 2.49% others (CSA, 2007). Tigrigna is the working language of the state and Tigray has various natural resources which facilitate the development of agriculture.

Hentalo Wajerat district is one of the 4 districts of the South-Eastern Zone of Tigray Region and is one of the drought prone and chronic food deficient districts in Tigray. It is bounded by Raya-Azebo in the South, Samre-seharti and Alaje districts in the West, Afar Regional State in the East, and Enderta in the North. Geographically the district is situated at $12^0$54’00” and $12^0$22’00” North Latitude and at $39^0$17’30” and $39^0$46’00” East Longitude. It covers a total land area of 1933.09 square kilometers and located 745 km north of the capital Addis Ababa and 38 km South from Mekelle, the capital of Tigray (WoARDO).

The total population of the district was 174,532 of which 86, 285 were male and 88,247 female in the year 2013 (CSA 2007). Out of the total population about 159,446 of the population is living in rural areas and 15,086 is living in urban areas. Average family size is five and population density of the district is 90.29 people per square kilometer (CSA 2007).

The altitude of the district ranges from 1400 meter above sea level to 2700 meters above sea level. Agro-ecologically the district is characterized as Arid zone comprising three agro-

ecological zones; Kolla (< 1500 masl), Weina-Degua (1500 – 2300 masl), and Degua (> 2300) that constitutes 13.75%, 63.75%, and 22.5% of the total area coverage of the district respectively. Rainfall in the district is characterized by one rainy season. The area is known of having uni-modal rainfall pattern that covers from June to September. Small area (16 %) of the district has bimodal rainfall pattern. The average annual rainfall generally varies between 435.26 mm-674.08 mm and the average minimum and maximum temperature is 15^0c and 30^0c respectively(BoFED,2004).

3.2 Nature and Sources of Data

The nature of the data was both qualitative and quantitative collected from primary and secondary sources.

Primary data for the study has been collected from selected sample households, focus group discussion, interview with key informants (committee members of water user's associations, peasant association executive committee members, Women development army, development agents and Wereda irrigation development experts) and field observations.

Secondary data was also collected from formal sources such as Bureau of Agriculture and Rural Development (BOARD), Bureau of finance and Economic Development (BOFED), Wereda Agriculture and Rural Development office (WoARDO) reports and Ceteral Statistics Agency CSA.

3.3 Research Strategy and Design

The advantage of employing qualitative and quantitative methods in research is getting increasing recognition among researchers. It enables to benefit from the insights that the two methods provide when used in combination. Moreover, the most effective research is one that combines qualitative and quantitative components (Babbie, 2003). Thus, the research strategies employed in this study combine both qualitative and quantitative methods.

Qualitative method is used to capture data pertaining local perception and opinions on the contribution of irrigation to household income using focus group discussion and key informant interview. Quantitative data on households' resource ownership, income status, food security status, demographic characteristics and other basic information was collected from sample

households using semi-structured questionnaire and by referring reports and documents of different Bureaus' and Offices'.

3.4 Sampling technique and sample size determination

The total household heads that are using irrigated agriculture at Gum-selasa and Shilena small-scale irrigation systems are 350 and 229 respectively. Although the size of population of the two study sites differ, equal number of sample households are selected from each for the convenience of the study. Accordingly to make the data more manageable a total of 120 sample households that is 60 from each sample areas have been selected. Each sample household was selected by lottery method from the prepared list of household heads (Sample frame) at each study areas.

3.5 Data collection

3.5.1 Primary data collection methods

Primary data have been collected using of household questionnaire survey, focused group discussion (FGD) with the community members, and interviews with key informants.

Household survey questionnaire

The study has collected primary data with the help of semi-structured questionnaire designed to obtain information from selected sample households. The household survey covered personal data, household resources, production and income, issues related to irrigation practice, and support issues.

The questionnaire were first prepared in English and translated later into the local language (Tigrigna) so that the respondents can easily understand the questions. In order to conduct the household survey, three enumerators who have completed 12th grade and able to speak the local language ('Tigrigna') were recruited from each study sites. The questionnaire were distributed and collected by the enumerators under a continuous supervision of the researcher. The enumerators have been trained for one day on the actual field works.

Key Informants

The primary data collected from sample farmers need to be further enriched by additional information gathered through key informants.

In addition to the household questionnaire surveys, intensive interview has been conducted with key informants including committee members of irrigation water user's association, executive member of peasant association, Women development army, development agents, Hitalo-Wojerat district irrigation development desk representative, irrigation expert and from wereda administration. According to this a total of nine key informants that is one committee member of irrigation water user's association, one executive member of peasant association, one Women development army from each tabias , one development agent from each tabias , one from Hitalo-Wojerat district irrigation development desk representatives, one irrigation expert from the Woreda Rural and Agricultural Development Office and one from wereda administration was meet based on their knowledge of irrigation practices in the study area. .

Focus Group Discussion

Regarding the focus group discussion, village elders, who were believed to be knowledgeable about the pre–irrigation and post-irrigation circumstances of the village including the socio-economic conditions of the community, model farmers' and the youth were identified and included in the discussion.

Separate sessions of discussion were arranged for male and female participants so that the groups were able to speak out their feelings freely and more comfortably. Two focus group discussions at each study areas were conducted and each focus group comprised six to eight individuals.

This enabled to get data about the contribution of irrigation to farm household income and to obtain opinions, attitudes and views from the group discussion participants and it helped to elaborate, clarify and crosscheck ideas and experiences that has been gathered through household survey.

3.5.2 Secondary data collection methods

Secondary data were gathered by referring documents and reports of relevant offices.

3.6 Data Processing and Analysis

The data that has been collected through households questionnaire entered to the Statistical Package for Social Scientists (SPSS) version 16, and has been processed and analyzed using frequency tables, mean and percentage.

Qualitative data were analyzed through systematically organizing the information and giving attention to local situations opinions, perceptions and preferences of households at the study areas.

A print-and-verify method of data entry checking was performed to avoid errors in the recording process. The missing values, zeros and not applicable values were identified for verification. Each variable was examined not only for outliers but also for the general acceptability of the figures compared to national and regional information from other sources. The inconsistent values were also checked with the questionnaire to identify data entry errors.

CHAPTER Four Results and Discussion

4.1Introduction

In chapters one and two the theoretical and historical evidences of the issues related to the study were presented while in this chapter primary assessment results of the study area are presented. Data collected through questionnaire and interview are presented, analyzed and interpreted using frequency tables, mean and percentage. As it is stated in chapter three, the sample size of this study is 120. All questionnaires were successfully collected. The Respondents were household heads from two Small-scale Schemes known as Gum-selasa and Shilena in tabias Ara and Frewoyni of Woreda Hintalo Wojerat.

In-depth interview has been conducted with key informants including committee members of irrigation water user's association, executive member of peasant association, Women development army, development agents, Hitalo-Wojerat district irrigation development desk representative, irrigation expert and wereda administration.

Focus group discussion was also held with village elders, who were believed to be knowledgeable about the pre–irrigation and post-irrigation circumstances of the village including the socio-economic conditions of the community, model farmers' and youths was identified and included in the discussion

The points that got much emphasis in the focus group discussion did include the major crops produced through irrigated agriculture, major source of income, factors affect irrigated income, economic effects observe as a result of irrigation, productivity of irrigation verses rain fed per hectare and current challenges of irrigation in the district.

Results of the findings are mainly discussed based on the data collected from questionnaires and interviews and triangulated with the information delivered from the focus group discussion and observation.

4.2 Demographic and Socio-economic Characteristics of the Sample Households

In this section, the sample households demographic and community characteristics are discussed so as to understand the various characteristics among the study households. Specific reference is given to family composition and educational level. Such analysis is essential to ensure an understanding of the context in which results were obtained.

4.2.1 Family Size of the Households and Age distribution

The average national family size according to 2007 population and housing census results is 4.7 and for that of the rural Ethiopia is 4.9 and for Tigray 4.6 (CSA,2007). In the case of the study area, the average household size was found to be 5 and 5.23 people per household in Gum-selasa and Shilena Small-scale irrigation schemes respectively.

Table 1: Family Size of Sample Households

	Gum-selasa			**Shilena**		
	Mean	Min.	Max.	Mean	Min.	Max.
Household size	5	3.00	9	5.23	3.00	9
Male household	5	1	9.0	5.3	1.00	7.00
Female household	5.3	1.00	9.0	5.35	1.2	9

Source: Survey Results

As per the practice in the area the economically active populations are those within the age group 12-65 years (Even though, the standard international definition of working population is 15-65) and this account 76% and 68% in Gum-selasa and Shilena respectively. This figure indicates that the household labour source in Gum-selasa SSI is much better than Shilena. Due to this reasons irrigators' use more hired labour to supplement scarce family labour in Shilena SSI.

Definitely, such marked difference of age group between the two irrigation systems needs further investigation. All members of household that are found between the age group from 12-65 including male and female participate in the agricultural activities though the skill and efficiency could actually be different. In Shilena SSI, age category that contains family members found between 12 and 65 years is low as compared to that of Gum-selasa. As explained by the respondents, irrigators use more hired labour than do in Gum-selasa. Their hired labour source is mostly from the surrounding peasant association.

Obviously family labour is very important resource on small farms. All family members except the very young (less than 12 years old) and very old (more than 65 years old) can supply productive labour. But the actual available supply is often difficult to measure because family labour has quantity, quality, time and often-custom dimensions. Difficulty in measurement arises from the fact that the different family age/sex population classes often generate different amount of labour service (e.g., as differentially provided by young men, women, older children and grandparents), and that some irrigation farm operations/tasks are labour-type specific while others can use any class of labour.

4.2.2. Education

Human capital is the basis for the development of the economy of individual in particular and that of the country in general. Education has significant role in developing countries like Ethiopia for accelerated technology transfer and adoption of modern production system. This is true for both Gum-selasa and Shilena SSI farm households.

Education equips the productive force with the necessary skill in improving the productivity level. Education according to Philips (1994 as cited by Haile, 2008), helps people with the necessary skills and knowledge to actively participate in different economic activities of their

surroundings, and promote entrepreneurship. Thus, it is expected that farmers with basic literacy and numeracy level can easily adopt new and productive agricultural technologies.

As indicated in the table 2 below the study revealed that 74.5% of the irrigator household members in Gum-selasa are literate while 25.5% of them are illiterate. On the other hand 77% of the irrigator sample household members are literate and 22.97% of them are illiterate in Shilena.

The response of key informant interview and tabia administrator's view indicates that the reason for the presents of high percent of educated house hold members of the irrigated households in both Gum-selasa and shilena SSI might be the result of irrigation users got high income from their irrigated plot to cover education costs.

Table 2: Educational Status of Household members in the Study Area

	Gum-selasa		**Shilena**	
	Number	**Percent**	**Number**	**Percent**
Illiterate	104	25.5	85	22.97
Read and Write Only	108	29.7	89	24
Elementary1-4	94	25.8	103	27.8
Elementary5-8	50	13.7	71	19
High School 9-12	8	2.2	22	5.9

Source: Survey Results

4.2.3. Household Farm Resources

According to FAO (1997), farm resources generally fall into two broad categories.

The first category is fixed resources that provide services over a number of years or at least over a period longer than the production cycle of short-term (seasonal, annual) crop or livestock enterprises. Common examples of this are land, machinery, and an irrigation system.

In this category, land is typically the most important that will usually provide its service indefinitely. As it is generally observed in study area arable land is neither abundant nor scarce.

Farmers plot size varies from 0.25 ha. to 1.5 ha.. Those farmers who own more land grow different crops using both rain fed and irrigation water in the study area. There are also farmers who solely depend on irrigated farming. These types of farmers are those who possess very small size of farmland.

Generally, the average farmland holding is 1.26 ha. in Gum-selasa and 1.30 ha in Shilena SSI this is a little higher than the national average land size that equals 0.95 ha. The figure for national average land size is based on the statistical abstract explained by the Central Statistics Authority (CSA, 1999). Infact, the maximum farm plot holding indicated in both study areas cannot be said large. But the existing difference between the maximum and minimum plot holding can be a reason for production and income variation among farmers.

Table 3:-Household Land Resource (N=60 in each study area)

	Gum-selasa			**Shilena**		
	Mean	Min.	Max.	Mean	Min.	Max.
Total land size (ha)	1.26	.25	1.5	1.30	.50	2.00
Irrigable land (ha)	0.25	0.25	0.25	0.41	0.25	0.75
Irrigated land (ha)	0.25	0.25	0.25	0.362	0.25	0.75
Rain fed land(ha)	1.00	0.5	1.25	.633	.250	1.75

Source: Survey Results

The livestock sub-sector, which is an integral component of the farming system, has a significant share in the asset base of farmers. The survey data revealed the households' livestock possession is not large. But according to the information obtained from focus group discussion and physical observation of the researcher, the figure could have been more than what was reported.

The reason for farmers under reporting of their asset is fear for additional government taxes.

In addition, farmers believe that if they genuinely tell what they have, they may be excluded from safety net and food aid eligibility, which mostly distributed during the drought period to minimize such problem the enumerators explain to farmers the objective of the study is only for academic purpose.

The productivity of livestock population was constrained by the multiple of highly interrelated factors such as poor feed in quality and quantity, the prevalent of different diseases, poor genetic breeds and poor management in both study areas. As it is the case in the entire of the Tigray Region, livestock in the study area are kept to meet the demand for draft power, milk, meat (to a lesser extent because they use to sell than to consume), as a store of wealth, and as means to debt relieving mechanism.

The mean distribution of oxen among the irrigation community is about 2 for both Ara and Firewoyni. But the mean distribution cannot clearly show the extent of oxen shortage as there are some families without owing a single ox.

The second farm resources category that includes items such as improved seeds, fertilizers and pesticides are essential inputs for increased agricultural production and productivity.

Obviously, the rate of production and productivity both in irrigation and rain fed agriculture is generally determined by the amount of money available to buy them.

4.3 Major Crops Grown Using Small-Scale Irrigation

The main field crops grown using small-scale irrigation schemes in the study areas are maize and barley and the dominant vegetables are onion and tomato. This is similar to the finding of Tadesse e tal (2004) in Donny and Bato Degaga small holder's irrigation schemes in the Awash Valley of Oromiya Regional state. Access to irrigation has been regarded as a powerful factor that provides a greater opportunity for multiple cropping, cropping intensity, and crop diversification (Saleth et al. 2003). Households who have access to small-scale irrigation can cultivate twice a year. Thus, irrigation increases the intensity of cropping.

Table 4: The major field crops and vegetables grown using small-scale irrigation

Crop types	Gum-selasa		Shilena	
	Frequency	Percent of irrigating households growing	Frequency	Percent of irrigating households growing
crops (Cereals)				
Maize	45	75	47	78.33
Barley	8	13.33	7	11.66
Maize and Barley	5	8.33	5	8.33
Others	2	3.33	1	1.66
Vegetables				
Onion	46	76.67	45	75
Tomato	5	8.33	4	6.67
Onion and Tomato	8	13.33	10	16.66
Pepper	1	1.67	1	1.67

Source: Survey Results

The major grain crops grown by using irrigation water are maize and barley. The two crops can be considered as the strategic crops for future development of irrigation systems. Maize is a major source of food /staple food/ and at the same time it is the most important source of animal feed than any other crop items. It is also easy to apply irrigation water to maize than other food grain crop types.

In crop (cereal) cultivation using small-scale irrigation, maize was the dominant. It is grown by 75% and 78.33% of irrigating sample households in Gum-selasa and Shilena small scale irrigation schemes respectively. Barley is the second major field crops, grown by 13.33 % and 11.67% of irrigating sample households in Gum-selasa and Shilena small scale irrigation schemes respectively (Table 4). Vegetables were the more commonly produced crops with small-scale irrigation systems. The most frequently grown cash crop was onion, grown by 76.67 % and 75% of irrigating sample households in Gum-selasa and Shilena small scale irrigation

schemes respectively. Onion is better than other vegetables in terms of amount of yields produced and demand in the market. Tomato and pepper were less commonly produced than onions. 8.33% and 6.67% of irrigating sample households in Gum-selasa and Shilena small scale irrigation schemes grew both onion and tomato, whereas only1% of households produced pepper in both small scale irrigation schemes.

Crops grown using small-scale irrigation were few in number (Table 4), but there are different reasons why they are grown by irrigating households. The major factors for production decision were household demand; appropriate for the climate and easy to apply irrigation in both irrigation schemes respectively. There are also other reasons such as requires less labour and water scarcity.

Table 5: Reason for selecting the major field crops and vegetables for irrigation

Reasons	Gum-selasa		Shilena	
	Frequency	Percent of irrigating households responding	Frequency	Percent of irrigating households responding
Household demand	30	50	31	51.66
Appropriate for the climate	14	23.33	13	21.66
Easy to apply irrigation	6	10	5	8.33
Others	10	16.66	11	18.33

Source: Survey Results

Farmers and extension workers reported that the productivity of irrigation land is almost double of what could be harvested from the main rain, if it is cultivated using improved seeds and chemical fertilizers. This is attributed to the fact that in rain fed agriculture water is a limiting factor and there has been better farm management practice of irrigation farming. According to the farmers and extension workers in both Shilena and Gum-selasa Small-Scale Irrigation Schemes reported to have harvested 9.2-9.3 quintals of Maize from one tsimdi (0.25 hectare) of land in 2013. On the contrary they produced 3.2-3.3 quintals of Maize from one tsimdi (0.25 hectare) of land on the same year using rain fed .This shows irrigated agriculture is more productive than rain fed agriculture.

Table: 6. Average yields in Quintal per Tsimdi (0.25 Ha.) for major crops at the Two schemes during the 2013 season.

Type of crops	Productivity, Average Quintal per Tsimdi in Gum-selasa in 2013		Productivity, Average Quintal per Tsimdi in Shilena in 2013	
	Irrigation	Rain fed	Irrigation	Rain fed
Maize	9.3	3.3	9.2	3.2
Barley	3.5	1.5	4	1.75
Onion	13.5	-	12.5	-
Tomato	17.5	-	17	-

Source: Survey Results

4.4 Households' Sources of Income

Access to productive resources such as capital, land and family labour is the determining factor for the households' income. There are different sources of household income in the study area although there is variation in the number and amount of their contribution.

As far as this study is concerned, sources of household income in study area classified into four main groups that includes; income from grain production (rain fed and irrigated), income from cash crop production, income from sales of livestock and livestock products and income from non-farm sources.

4.4.1 Income from Food Grain Production

The production of food grain crop includes maize, wheat, barley, pulses and teff in the irrigation systems. The sizes of farmland cultivated under rain fed for the production of grain food crops is larger than farmland cultivated by applying irrigation water. For instance, the average farmland cultivated by rain fed for the production of food grain crops for the three years period (2011-2013) is .75 ha. and .76 ha. in Gum-selasa and Shilena SSI respectively.

The major grain crops grown by using irrigation water are maize and barley. The two crops can be considered as the strategic crops for future development of irrigation systems. Maize is a major source of food /staple food/ and at the same time it is the most important source of animal feed than any other crop items. It is also easy to apply irrigation water to maize than other food grain crop types.

On the other hand, barley is a useful crop, which is produced mostly for the market. This is due to its relatively better demand and good market price that encourages producers. Its water application and other field operation is not difficult to farmers.

The climate and soil are also very conducive for the production of these two crops. Local seeds that are appropriate for the climate are available in the study area. In this case, it would be easy to increase the contribution of these two crops provided that problems of market information and transportation facilities are improved.

That means, in order to make the irrigation systems more effective, adequate public infrastructure of both physical and institutional nature should be well addressed. Market access is probably the most important infrastructure. Institutionally, the government needs to ensure a mechanism in which irrigation farmers are accessible for transport, storage, market, research and other services.

The following table shows area cultivated under rain fed and irrigation for the production of various cereal crops.

Table 7: Area Cultivated Under Rain Fed and Irrigated Agriculture

Type	**Year**	**Gum-selasa**			**Shilena**		
		Number of household heads	Mean land cultivated in hectare	Total land cultivated in hectare	Number of household head	Mean land cultivated in hectare	Total land cultivated in hectare
Irrigated Agriculture	2011	40	0.25	10	41	0.32	13
	2012	53	0.25	13.25	52	0.36	18.72
	2013	59	0.25	14.75	60	0.36	21.60
Rain fed Agriculture	2011	53	0.75	39.75	54	0.75	40.5
	2012	55	0.73	40.15	55	0.72	39.6
	2013	58	.73	42.34	57	0.72	40.81

Source: Survey Results

As shown in table 8 below, farmers largely concentrated on the production of food grain crops under rain fed cultivation. Farmers use irrigation water for the production of cash crops than for the production of food grain crops.

The production of food grain crops under irrigation cultivation per tsimdi/0.25 hectare was significantly better than the production under rain fed cultivation. The reason for high difference between the two production systems was that crops under rain fed are affected differently by shortage of rainfall.

Table 8: Grain Crops Production from Rain fed and Irrigation Agriculture (Qt)

Type	**Year**	**Gum-selasa**			**Shilena**		
		Number of household heads	Mean of production in quintal	Total production in quintal	Number of household heads	Mean of production in quintal	Total production in quintal
Irrigated Agriculture	2011	40	9	360	41	9	369
	2012	53	9.2	487.6	52	9.25	481
	2013	59	9.3	548.7	60	9.20	552
Rain fed Agriculture	2011	53	3.4	180.2	54	3.5	189
	2012	55	3.2	176	55	3.3	181.5
	2013	58	3.2	185.6	57	3.3	188.1

Source: Survey Results

As indicated in table 9 below, the estimated mean income obtained in the year 2011, 2012 and 2013 from irrigation cultivation was higher than production gain under rain fed cultivation.

This income was produced from the mean land cultivated in hectare presented on table 7 for both irrigated agriculture and rain fed agriculture. The reason for this variation was irrigator farmers produce twice a year besides the output per hectare is higher in irrigated agriculture than in rain fed agriculture.

For example in 2013,the mean income per household was 2,900 birr from 0.25 hectare average cultivated land through irrigation ,but 1,170 birr mean income from 0.73 hectare cultivated land through rain fed in Gum-selasa.

Similarly in 2013, the mean income per household was 2,835 birr from 0.36 hectare average cultivated land through irrigation, but 1,150 birr mean income from 0.72 hectare cultivated land through rain fed in Shilena. This shows even though the average cultivated land under rain fed is almost three times larger than the average cultivated land through irrigation; the mean income from irrigated agriculture is more than double as compare to mean income obtain from rain fed agriculture.

The income obtained from food grain crops and cash crops production was based on farmers' estimation of market price during the study periods.

On the other hand, the trend of food grain crop production by using rain fed agriculture did not increase. This is due to farmers' preference of cultivating by irrigation water. i.e. farmers increase commitment to engage themselves in irrigation activities.

For instance, the share of income obtained from irrigated food grain crops production as compared to income from rain fed food grain crops produced in 2013 was 71% and 72.5 % in Gum-selasa and Shilena respectively.

Table 9: Household Income Obtained from Rain Fed and Irrigated Grain Sells (in Birr)

Type	**Year**	**Gum-selasa**			**Shilena**		
		Number of household heads	Mean income in Birr per H.H	Total income in Birr	Number of household heads	Mean income in Birr per H.H	Total income in Birr
Irrigated Agriculture	2011	40	2000	77800	41	2221	107461
	2012	53	2200	107325	52	2331	173212
	2013	59	2900	143016	60	2835	224100

Rain fed Agriculture	2011	53	1450	76850	54	1475	79650
	2012	55	1257	69135	55	1300	71500
	2013	58	1170	67860	57	1150	65550

Source: Survey Results

4.4.2 Income from Cash Crop Production

As far as this study is concerned, cash crop refers to vegetable crops produced through irrigation for the purpose of market to increase household cash income.

Therefore, farmers in both irrigation systems produce high value horticultural crops such as onion, tomato and pepper. Papaya and mango are also grown around homestead. But in most cases the major cash crops are onion and tomato.

According to the survey, some farmers do not cultivate their irrigable plots all in all by using irrigation water. Many reasons were raised during household interview and focus group discussion among which is; shortage of water, lack of capital to purchase farm inputs, inconsistency in market prices and low commitment on the part of irrigators themselves. The maximum cash crop production intensity is two in most case which otherwise once in a year in both irrigation systems.

As indicated in table 10, the average farmland cultivated for cash crop production throughout the three years was constant in Gum-selasa while it has been increasing in Shilena SSI.

As noted by the informants, there are two reasons for this. First, the irrigators in shilena are small in number as compare to gum-selasa besides its water supply is much better than Gum-selasa SSI. Second, Farmers in Gum-selasa SSI has better experience in cash crop production than farmers in Shilena SSI and farmers in shilena has larger irrigable plot than farmers in Gumselasa.

Table 10: Cultivated Area for Cash Crop Production (ha)

Year	**Gum-selasa**			**Shilena**		
	Number of household heads	Mean land cultivated in hectare per H.H	Total land cultivated in hectare	Number of household heads	Mean land cultivated in hectare per H.H	Total land cultivated in hectare

2011	56	.25	14	57	0.32	18.24
2012	58	.25	14.5	59	0.36	21.24
2013	60	.25	15	60	.36	21.6

Source: Survey Results

The size of farmland cultivated for the production of cash crops relates to the experience and technical management skills of individual farmer.

The financial status of a farmer (market demand) is also another important factor to limit farm size. Few farmers do not pay enough attention for their irrigated plot instead they grow low value grain crops once in a year by waiting for the rainy season. Because cash crop production requires high capital and farmers strong commitment to fully engage them in farm activities all along the production season.

According to the discussion held with committee members of irrigation water user's associations, those who use to apply irrigation demands more labour than rain fed cultivators.

The reason is irrigation requires more labour than rain fed cultivation. That means with rain fed cultivation it is possible to leave the farm from time to time to participate in other non farming activities, as no great harm comes to the crops. But under irrigation, water must be applied when it is due, and under harsh climatic conditions a day or two of delay in watering may result in serious crop losses. Most of irrigation farm household members are therefore much more tied to their land when it is irrigated.

Table 11: Types of Cash Crops Grown and Cultivated Land in Percentage

Crop Type	**Gum-selasa**			**Shilena**		
	Area cultivated 2011	**Area cultivated 2012**	**Area cultivated 2013**	**Area cultivated 2011**	**Area cultivated 2012**	**Area cultivated 2013**
Onion	87% (197,167Birr)	93% (254,120.5Birr)	96% (264,354.3Birr)	84% (173,317Birr)	93% (253,891.13 Birr)	97% (270,859Birr)
Tomato	13% (24,369Birr)	6% (7,873.5Birr)	4% (4,025.7Birr)	16% (25,898 Birr)	5.5% (6,526.87 Birr)	3% (1,361 Birr)

Pepper	-	1% (4,56 Birr)	-	-	1.5% (6,57 Birr)	-

Source: Survey Results

As shown in table 11, the production of onion takes the lion's share in both irrigation systems.

The negative aspects of such high degree of production concentration on one crop item (onion) create competition among producers for market, which in most cases excess production results in price decline. Farmers reported the following reasons why the production of onion is most preferred.

- The local seed of onion is easily obtained
- Irrigation water application and field management of onion crop is relatively easier
- Onion is less perishable crop and it is easy to harvest and transport as compared to tomato which is the second highly produced cash crop in the study areas.
- It withstands diseases as compared to other crops

On the other hand during focus group discussion farmers noted that they do not grow perennial horticultural crops because requires long time for maturity and production and this is not tolerable for subsistence farmers whose livelihood is highly dependent on fast growing seasonal crops. That is why only very few farmers planted mango and papaya to a lesser extent around the backyard and scarcely on the borders of their plots. The volume of production is also very low therefore it is mostly consumed in the household.

The average household income obtained from sale of cash crop shows an increasing trend in both Gum-selasa and Shilena SSI. This is due to good experience of farmers in irrigation (increase production) and increase in demand and price of cash crops. The average cash income obtained by the producers of the two irrigation schemes has shown in table 12, below.

Table 12: Average Income from Sales of Cash Crop Products (in Birr) per year

Year	**Gum-selasa**			**Shilena**		
	Number of household heads	Mean income in Birr per H.H	Total income in Birr	Number of household heads	Mean income in Birr per H.H	Total income in Birr
2011	56	3,956	221,536	57	3,495	199,215
2012	58	4,525	262,450	59	4,425	261,075

2013	60	4,473	268,380	60	4,637	272,220

Source: Survey Results

4.4.3 Income From Livestock and Other Farm Products

In arid zone where crop failure is frequent, farmers consider livestock as an essential for their survival. Generally, income from livestock include sales of animals such as oxen, cows, goat, donkeys, etc. and also livestock products like butter. Other farm products such as hens and eggs are sold to raise income to purchase food crops and other industrial products used for household consumption. As the informants explained, the contribution of irrigation in providing fodder to animals in the form of weeds and residue was not underestimated. The following table 13 summarizes income derived from livestock and livestock products for the three years (2011-2013).

Table 13: Income from Sales of Livestock and Livestock Products (in Birr)

Year	**Gum-selasa**			**Shilena**		
	Number of household heads	Mean income per H.H per year	Total income	Number of household heads	Mean income per H.H per year	Total income
2011	27	7,20	19,440	21	7,90	16,590
2012	29	7,85	22,765	29	7,95	23,055
2013	29	8,10	23,490	29	8,05	23,345

Source: Survey Results

From table 13 above, the number of household heads getting income from livestock and livestock products are below halve (< 30) and the average income per household per year is small in both Gum-selasa and Shilena small scale irrigation schemes. For example in 2013, the number of household heads were 29 and their mean income was 8,10 birr per year in Gum-selasa and the number of household heads in Shilena were 29 and their mean income was 8,05 birr per year. This shows the share of livestock and livestock products income to total household income is small that is 8.8% and 8.2% in Gum-selasa and Shilena respectively.

4.4.4 Off- Farm and Non-Farm Activities

There are different types of non-farm and off farm activities undertaken by some farmers to supplement their household income. The households' income indicated in table 14 was obtained from different types of off-farm and non-farm activities such as sales of firewood and charcoal, petty trading, wage labour and hiring out oxen.

Families that are engaged in such activities are mostly poor whose agricultural income is not enough for their annual consumption.

Table 14: Income from non-Farm Sources (in Birr)

Year	**Gum-selasa**			**Shilena**		
	Number of household heads	Mean income per H.H per year	Total income	Number of household heads	Mean income per H.H per year	Total income
2011	4	200	800	5	180	900
2012	7	240	1680	6	210	1260
2013	5	230	1150	4	200	800

Source: Survey Results

From table 14 above, the numbers of household heads getting additional income from non-farm sources are very few and the average income per household per year is also very small in both Gum-selasa and Shilena small scale irrigation schemes. For example in 2013, the number of household heads was 5 and their mean income was 2, 30 birr per year in Gum-selasa similarly the number of household heads in Shilena were 4 and their mean income was 2, 00 birr per year. This shows the share of non-farm income to total household income is very small that is 2.5% and 2% in Gum-selasa and Shilena respectively.

4.4.5 Comparison of Households' Source of Income

As discussed earlier, there are different sources of household income in the study area. The degree of contribution of each source of income depends upon the economic situation of individual farmers. But as one can see from the table 15 and 16 below, the share of cash crop is significantly higher than any other income source. This shows even under the existence of some constraints, the production of cash crop seems very important to the irrigation communities. In this case, if both irrigation systems manage to apply high crop intensity (growing two to three crops per year) combined with market oriented cropping pattern, the effect would be tremendous. Table 15 and Table 16 compare households' income by sources for the three years period.

Table 15: Comparison of Average Household Income by Sources in Gum-selasa(in Birr).

Source of Income	2011		2012		2013	
	Mean Income	Per cent income	Mean Income	Per cent income	Mean Income	Per cent Income
Cash crop (Irrigated)	3956	47.5	4425	49.7	4537	49
Irrigated Grain Crop	2000	24	2200	24.7	2500	27
Rain fed Grain Crop	1450	17.4	1257	14	1170	12.7
Livestock Sources	720	8.65	785	8.8	810	8.8
Non- farm Sources	200	2.4	240	2.7	230	2.5

Source: Survey Results

The average household income obtained from sales of cash crops shows that there is an increasing trend in the study area throughout the three years period. This indicates that farmers are becoming more interested in the production of cash crops as they are becoming aware of its importance.

Table 16: Comparison of Average Household Income by Sources in Shilena(in Birr)

Source of Income	2011		2012		2013	
	Mean Income	Per cent income	Mean Income	Per cent income	Mean Income	Per cent income
Cash crop (Irrigated)	3,495	43	4,425	49	4,637	47
Irrigated Grain Crop	2,221	27.2	2,331	25.73	3,035	31
Rain fed Grain Crop	1,475	18	1,300	14.35	1,150	11.7
Livestock Sources	7,90	9.7	7,95	8.8	8,05	8.2
Non Farm Sources	180	2.2	210	2.32	200	2

Source: Survey Results

Table 15 and table 16 indicates that the average income of three years study period obtained from irrigated food grain crop and cash crop production together constituted 74% and 76.8% as compared to other sources of income in Gum-selasa and Shilena SSI respectively. Besides tables 17 and 18 indicates the total income of the three years by sources in both Gum-selasa and Shilena Small-scale irrigation schemes respectively.

Table 17: Comparison of Total Household Income by Sources in Gum-selasa (in Birr)

Source of Income	2011		2012		2013	
	Total Income	Per cent income	Total Income	Per cent income	Total Income	Per cent income
Cash crop (Irrigated)	221,536	55.88	262,450	56.64	268,380	53.26
Irrigated Grain Crop	77,800	19.63	107,325	23.16	143,016	28.38
Rain fed Grain Crop	76,850	19.38	69,135	14.92	67,860	13.47
Livestock Sources	19,440	4.90	22,765	4.91	23,490	4.66
Non Farm Sources	800	0.20	1,680	0.36	1,150	0.23

Total	396,426		463355		503896	

Source: Survey Results

Table 18: Comparison of Total Household Income by Sources in Shilena (in Birr)

Source of Income	2011		2012		2013	
	Total Income	Per cent income	Total Income	Per cent income	Total Income	Per cent income
Cash crop (Irrigated)	199,215	49.33	261,075	49.25	272,220	46.45
Irrigated Grain Crop	107,461	26.61	173,212	32.68	224,100	38.24
Rain fed Grain Crop	79,650	19.72	71,500	13.49	65,550	11.18
Livestock Sources	16,590	4.11	23,055	4.35	23,345	3.98
Non Farm Sources	900	0.22	1,260	0.23	800	0.14
Total	403,816		530,102		586,015	

Source: Survey Results

4.5. Households' Food Security

Obviously high proportion of households food supply is generated from own agricultural production. From table 19 below 85% in Gum-selasa and 95% in shilena SSI produced sufficient produce for one year. This shows the contribution of own agricultural production is significantly high to cover households' food requirement. Even though the own agricultural production is high, it is very difficult to conclude food is secured in the study area without assessing the other food security elements like sufficiency, security and time.

The following table shows the condition of households' food security for the last three years in both irrigation schemes.

Table 19: Condition of Household's Food Security (2011 to 2013)

Households Level of Food Security	Gum-selasa		Shilena	
	Frequency	Percent	Frequency	Percent
Excess production	3	5	6	10

Sufficient for one year	48	80	49	81.67
Sufficient for six month only	2	3.3	3	5
Sufficient for 8-10 months	7	11.67	2	3.33
Total	60	100	60	100

Source: Survey Results

4.6 Factors promote small scale irrigation

4.6.1 Agricultural Extension

Extension service was one of the policy focus taken by the Ethiopian government in general and that of the Tigray regional state in particular as a vital tool for the peasants to be transformed from the traditional to modern agricultural system and hence improve the well-being of the poor household through increasing productivity per unit area of land.

According to Van Den Ban and Hawkins (1988), the main aim of extension program is to initiate change to bring about sound agricultural development especially on the part of smallholder farmers. It offers them technical advice and also supplies with the necessary inputs and services. Agricultural extension is therefore used as a tool for rural development.

On the other hand, extension work is not an arbitrary activity it requires systematic planning in order to bring about the desired change.

Farmers practice irrigation without essential technical know-how on crop water management, water application methods and irrigation intervals. For instance, according to the estimates of farmers producing tomato, the production lose is about one third because of farm level mismanagement and post harvest mishandling (Tadesse e tal, 2004).

That means on farm level farmers do not apply the technique of keeping the tomato plant on the raised bed to prevent its fruits from attaching to the ground, which causes decrease in its quality. Farmers lacking proper knowledge on irrigation water management also resulted in wastage of water, intensified salinity and water logging problems.

In this case, the major role of development agents should be to enlighten and equip farmers with sufficient and appropriate knowledge in order to change their attitude in a certain desirable direction. There are of course two development agents trained in general agriculture including special training in irrigation water management that enables them to provide proper advice to farmers assigned to the irrigation systems.

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

The existing cropping pattern has been found to be effective and the cropping intensity is also good. In most cases, majority of farmers produce twice in a year by using irrigation water. From the study it was understood that farmers tend to concentrate on irrigated plot than on rain fed plot. Adoption of inter-cropping, good cropping intensity and presence of market oriented cropping pattern are the major indicators of the effectiveness of the existing extension service.

Two extension workers are assigned at each kebelle (tabias) to implement and follow the regionally and nationally designed extension package programs as their daily activities.

The regional or national extension program is area specific problem solving approach and it is decentralized.

Therefore, every expert should work according to the rules and principles of the extension program and one's professional ethics.

 The regional government is also give good emphasis to the implementation of the extension package program. Most of the district level experts including Development Agents are engaged their full time in helping the farmers during land preparation, planting/transplanting, weeding, applying agro chemicals, watering and harvesting.

The organizational set-up and its structure also play important role in provision of sustainable extension service to the farmers. The motivation of staff is also a key factor that may determine the success or failure of the extension program. A motivated individual will be more effective in motivating small group of people, with whom one is working closely. However, as understood from the discussion and practical observation in the field, the development agents are not

satisfied with their salary. Therefore, there is some turnover of qualified and well experienced extension staffs.

There is also budget constraint, most of the time district level experts including Development Agents are obliged to cover cost of their field work by themselves no matter how much they stay out. For instance, in addition to absence of per-diem payment, Development Agents are also required to pay for the maintenance of the bicycles from their own pocket that will not be reimbursed and this condition discourages them to carry out fieldwork.

4.6.2 Input services

Related to the production of high value horticultural crops, both input and output side of marketing is considerably important. Farmers in the study area have accessed to fertilizer because the district agriculture and rural development office supply fertilizer to both irrigators and non irrigator farmers.

Therefore, farmers be it irrigators or rain fed cultivators relay on fertilizers. Even though majority of the farmers use fertilizer to their plot, very few farmers do not use fertilizer because of financial shortage.

The condition of fertilizer application by irrigation farmers is shown in table 20, indicated below.

Table 20: Rate of Fertilizers Utilization in Gum-selasa and Shilena SSI.

Fertilizers Application	**Gum-selasa**		**Shilena**	
	Number of Users	**Percentage**	**Number of Users**	**Percentage**
Apply	58	96.67%	57	95%
Do not apply	2	3.33%	3	5%

Source: Survey results

Majority of the farmers that use fertilizer as an input for the production of high value horticultural crops and low value food grain crops apply the recommended rate based on their will. Therefore, the amount of production depends on the amount of fertilizer used provided that

all other factors remained same. From table 20, 95.84% of the irrigators use fertilizer for their plot.

Among reasons mentioned by farmers for not using recommended rate of fertilizer was cash shortage (4farmers) and fertilizer is not useful. (1 farmer) Generally the application of fertilizer corresponds with farmers' ability to purchase fertilizers. According to the Woreda Agricultural and Rural development office the recommended rate is two quintal per hectare.

On the other hand, the existing stocks of animal population in the study area provide the opportunity to utilize manure to increase soil fertility and the practical application is high except very few farmers do not use manure because they used manure as alternative for fuel and lack of commitment on the part of the farmers. That means farmers are not willing to transport manure from home to farm plots.

Table 21: Number of Farmers Apply Manure

Application of manure	**Gum-selasa**		**Shilena**	
	Number of Users	**Percentage**	**Number of Users**	**Percentage**
Apply	58	96.67%	56	93.33%
Do not apply	2	3.33%	4	6.67%

Source: Survey Results

Tigray seed multiplication and processing center is the responsible governmental institution for the multiplication of horticultural crop varieties for transfer to end users in the region besides Relief Society of Tigray is also participating in the multiplication of horticultural crop varieties.

This enables farmers to grow high yield crop varieties, which are highly demanded in the market with high price.

On the other hand, although irrigation demands more input that requires high finance, the local government gives priority to irrigators embraced by extension package program.

Extension intervention program which is usually known as "package" was initially designed and implemented by SASAKAWA Global 2000 and later adopted by the national and regional governments to be implemented on a wider scale (BOARD, 1995). This program is based on the assumption that there exists a sufficient improved technology to increase crop yields of the participating farmers. Those farmers who are selected to be embraced by the package program will be provided the privileges such as credit service and technical assistance with close farm supervision (ibid).

Therefore, irrigation farmers are embraced in to the package program by the regional government. In relation to output marketing, even though both schemes are not far from the main road that access to major towns like Mekelle, Adigrat, and Michew, the marketing system is not well organized. The nearby local markets do not have the capacity to absorb the perishable produce of farmers. At the same time the price received by farmers in the primary markets is relatively lower than what they could have received in other big markets like Mekelle. Market information on the part of farmers is not that much strong. As a result, farmers do not have the bargaining power to determine the price of farm produce; instead they accept the price given by the traders.

4.6.3 Credit Service

Irrigation farm management requires more financial input than rain fed agriculture do. Since there are micro-financial institutions like DEDEBIT and other saving and credit cooperatives in the study area majority of irrigators in both study area are capable to meet capital requirement needed for the production activity.

Hence majority of farmers are able to purchase farm implements which are used for irrigation operation like oxen, chemicals and biological in puts which increase irrigation performance.

Table 22: Purpose of the loan (multiple responses are possible)

Purpose of the loan	Gum-selasa	Shilena

	Frequency	percent	Frequency	percent
To purchase oxen	10	16.67	8	13.33
To purchase farm implements	15	25	17	28.33
To purchase fertilizer	58	96.67	57	95
To construct house	4	6.67	3	5
To buy improved seeds	17	28.33	18	30

Table 22 revealed that from those who took credit, 96.67% of the irrigation beneficiaries in Gum-selasa and 95% of the irrigation beneficiaries in Shilena used the loan to purchase fertilizers, 25% of the irrigators in Gum-selasa and 28.33% in Shilena used the loan to purchase farm implements, 28.33% in Gum-selasa and 30% in Shilena used the loan to purchase improved seeds, 10%in Gum-selasa and 8% in Shilena used to purchase oxen and 6.67% and 5% in Gum-selasa and in Shilena respectively used to construct house .

The finding shows that fertilizer is a critical modern input for productivity in the study area followed by improved seeds. For instance from the interviewed irrigators 95% in Gum-selasa and 97% in Shilena SSI farmers said credit is available timely and adequately when needed to buy farm implements. This large percent indicates the support of the regional government to promote small scale irrigation and increase irrigators' income or production was significant.

4.6.4 Training in Irrigation Management

According to the information obtained from the key informants, training was only given to Abo-may and model farmers by the district rural and agricultural development office in collaboration with Relief Society of Tigray. But the majority of farmers have only got information related to irrigation water management from Development Agents. Training should be given continuously; otherwise, an irregular and partial training cannot bring about a desired effect on the production and productivity of irrigation agriculture.

4.6.5 Constraints in Irrigation

Even though the Regional government in collaboration with other concerned institutions supported the irrigation farm households with different input and credit services, technical supports and supportive policies, the farm households has pointed out some limitations which affect the irrigation performance negatively during the study.

The following table illustrates the extent of the problem of both irrigation systems as rated by the farmers themselves.

Table 23: Problems Affecting Irrigation Performance (income) as Rated by Farmers

No	Factors	Gum-selasa	Shilena
1	Lack of Storage facility	56	57
2	Market problem for cash crop produce during harvesting period	60	60
3	Lack of market information	27	29
4	Water salinity	19	16
5	Irrigation water shortage	12	14
6	Lack of skill training of irrigation	21	24
7	High cost of modern input	20	17
8	Shortage of oxen	13	7

Source: Survey Results

4.6.6 Livestock and Irrigation

According to Berhanu and Peden (200), in mixed crop-livestock system the opportunity that irrigation provides is not only enabling intensified crop production, but also increase animal feed through increased crop residues of food-feed crops, which may reduce the pressure on grazing lands. If farmers well manage and utilize fodder that can be grown by the use of irrigation, livestock productivity can increase hence household income can be increased.

Obviously, livestock production is one of the very important aspects of income generation for households in both irrigation systems. They are closely integrated with the range of purposes such as direct production, draught power, transport, and manure production to sustain soil fertility and as a store of wealth.

Livestock products that are mostly consumed in the household such as milk, butter, cheese, are sources of good quality of proteins. Traditionally, selling of livestock product especially milk is not widely undertaken because of cultural and religious beliefs. Therefore, it is consumed mostly in the household. The consumption of this food item is very useful especially for children for their better growth and health.

Small animals such as goats and sheep are kept mostly for sale at time money is crucially needed for the settlement of different household's financial commitments.

They are also used as the major source of meat for the household though they are rarely slaughtered. The feed requirement of these animals is not as big as larger animals since their feed is usually depend on grazing and browsing.

According to the respondents, the impact of irrigation development on livestock is not as high as crops in the study area. In addition to crop residue, weeds are also important source of animal feed. Usually irrigators weed their farm once or twice depending up on the intensity of weed. According to the irrigators, as far as they collect weeds from their farm for the feed of their animals, they do not use herbicides so that they can save money which otherwise costs them high. With regard to livestock, one woman was interviewed in Gum-selasa SSI to give suggestion whether irrigation helped her to get increased amount of milk from the cow she is currently milking. She responded in smiling face that after the introduction of the irrigation system, her family diversified their crops and succeeded to harvest up to two times in a year. She added, the advantage of irrigation to her family is not only limited to benefiting high income

from cash crop but the volume of milk she gets from her cow also increased. As she witnessed, in the absence of irrigation she use to milk quarter to half litter of milk per day for only six months duration. But now, thanks to irrigation, she managed to get more than one litter of milk per day from the same cow. If all things go normal, she is confident that she would continue milking with the same volume of milk for a year.

Of course, this may not be the case in all irrigation families. But good experience of this woman explained above can have a demonstrative effect on other women in both study areas.

The extension service in relation with livestock production is very weak. The development agents assigned in both study area only looks after farmers' crop production neglecting the livestock part. This shows there is no appropriate mandate and integration between crop and livestock production. Although the woreda agricultural and rural development office as well as Relief society of Tigray undertake different activities such as distribution of improved cattle breed, artificial insemination service, forage seeds and health service, the result was not significant.

Neglecting livestock and concentrating only on crops obviously affect farmers whose source of income is essentially depend on crop livestock integration.

In this respect, irrigation should also benefit the livestock sector. For instance, livestock provides the most valuable and cheaper farm in put, manure, which is very essential to maintain soil structure and fertility. The output of livestock products such as milk, milk products, meat, hides and skins can also be significant source of income if the benefit of irrigation properly channeled to this sector.

Generally, the livestock production in the study area is hampered by multiple factors such as feed shortage, low productivity of local breed, disease prevalence, insufficient veterinary services, poor animal husbandry practices and undeveloped market infrastructure.

4.6.7 Policy Issues of Smallholders Irrigation Development

In principle local and the national governments are expected to provide regulatory frame works, policies and public goods that are useful to facilitate smallholder irrigation development. For instance, the input and output side of marketing is considerably important for irrigation systems to grow. Agricultural marketing is considered to consist all activates that link farm producers with consumers. The marco-economic policy environment can determine this linkage. One aspect of such policy is the agricultural price policy, which contains the type and form of the

government intervention in the markets of agricultural produce. There is a high price fluctuation of agricultural production and leaving it to the interplay of market forces result in the set back with the overall rural economy. In this regard, there is no clear policy that enables farmers to get reasonable price for their produce.

Since the regional government import and provide chemical fertilizers to farmers at reasonable price majority of farmers able to shift from the production of low value food crops to production of high value cash crops. The local government does not provide storage facilities to farmers in both study area, due to this farmer's income is affected.

Although water pricing may involve some technical, administrative and political constraints, water pricing is essential to tackle with increasing water scarcity and declining financial resources available for irrigation and water development. There is no policy in the region as a whole that entails about water right and entitlement. Water is rather considered as common property resource. Nevertheless, there should be water-pricing system based on water rights that would introduce incentives for efficient water use and recover at least organization and management costs.

4.7 Economic Linkages

The idea of linkage in relation to this discussion refers to the development of different aspects of production activities and services created and/or facilitated as a result of small-scale irrigation development. Evaluating the existing linkages is certainly very important to show the contribution and socioeconomic impact of irrigation systems in local economic development.

Hirishman (1958 in Ray 1998) explained that there are various linkages that connect different fields of activities whether it is manifested in the form of backward and forward or in one of it.

Forward linkages are essentially facilitators in that they increase the viability of other economic activity from the point of view of production, from the supply side. Backward linkages increase the demand for the product of another sector.

As far as this study is concerned, four types of linkages of irrigation have been identified although the level of its strength is very low. These are production linkages, consumption linkages, investment linkages and employment linkages. The elements of these linkages are manifested either in the form of forward and backward linkages or by any one of it as discussed below.

4.7.1 Production Linkages

With this type of linkages the modality of forward linkages has not been observed since there are no small-scale processing industries that use farm products as raw materials. What have been observed were only backward linkages in study area. The increased income obtained by farmers because of irrigation in turn created high demand for modern farm inputs such as (improved seeds, fertilizers, pesticides, veterinary drugs etc.) and farm implements that are used specially for irrigation farm operation.

4.7.2 Consumption Linkage

With this type of linkage modality, cereal crops such as maize, barly, teff etc. are sold by farmers in the nearby markets. Adigudom and Hiwane are market towns and serve as centers for collection of these cereal products brought from the two irrigation systems and the surrounding farmers as well.

Both Adigudom and Hiwane are small market towns where the sales of crops are generally carried out in the open air, as "open markets" without any permanent shelters or retail shops.

Regarding cash crops such as onion and tomato, most part of the products are sold in distant markets like Mekelle, Michew and Mokoni. Only very little of these vegetable products are sold in the surrounding market places and also consumed by irrigation farm households.

In rare cases farmers sale their cash crop products on the farm before harvest for traders who come from the above-mentioned towns. But this does not mean farmers always get good price for their cash crops since the undeveloped market infrastructure do not allow them to look for other options.

Backward linkages of the consumption linkage modality is reflected by the farmers increased consumption of various types of industrial goods like food oil, kerosene, salt, soap, sugar, cloths, etc. Irrigation has increased households income as a result the ability of irrigation users to spend on different social services such as education and health also increased.

4.7.3 Investment Linkages

Hirishman (1958 in Ray 1998) explained that the higher the saving rate the greater the investment capability and the higher the growth rate. The rate of saving and investment in both human and physical capital has a growth effect. Accumulation of capital by an individual will make workers very productive and increase the productivity of capital and other workers in the

economy. This means that there are complementarities among action of agents in way one agents of choice of action increases the incentive for other agents to take some sort of action.

As far as the two irrigation schemes are concerned, the forward aspects of investment linkage is very weak as most of the irrigators are yet found at subsistence level with only few of them saves at small rate. In this case no significant progress has been observed in investment.

4.7.4 Employment Linkages

The employment linkages are relatively strong in both irrigation systems. For instance, Job opportunity has been created of which many landless young people especially poor women subsist as farm labourers. Irrigation farms are the significant source of employment.

Other obvious groups of external beneficiaries consist of village traders, whole sellers, brokers and local governments as taxing authorities. For instance, broker is a new kind of job created in both areas as a result of cash crop markets. There are about three brokers at Gum-selasa and two at Shilena SSI who earn 75 percent of their annual income from this deal.

According to the information received from focus group discussion, the average annual income of these brokers range from 3,000-6,000 Birr depending upon good condition of cash crop production and better price.

Another important advantage of irrigation is its contribution to minimize the out migration of landless poor people to other places for the search of temporary job. Irrigation being the main economic activity helped the surrounding poor people to work and earn either to supplement their low income or as a means of sole income generation.

CHAPTER FIVE Summary, Conclusion and Recommendations

5.1 Summery

The history of irrigation shows that irrigation has played a key role in increasing farmer's income where it is well managed by lowering the risk of crop failure. Irrigation development aims to increase agricultural income and to improve the economic welfare of the rural societies. Irrigation plays a big role in filling the gap in food shortage and to achieve long-term food security. The high and market oriented yields obtained from irrigation and other benefits such as creation of employment opportunity, reduced consumption shortfalls and food security are an indication that irrigation can bring about development and the end of poverty.

This study had paid significant emphasis on contribution of small –scale irrigation to household income and food security in Hintalo-wejerat of South-Eastern Zone, Tigray Region. In this study attention was given to the role of irrigation in increasing agricultural production and income in the study area.

The study Woreda is one of the most drought prone and food insecure areas of Tigray region. Despite the low productivity and recurrent drought in the study area, it is believed that crop production can be sustainable through development of small-scale irrigation schemes in areas endowed with perennial water sources. The result of this study also reveals that in the history of drought in the area, those households who have access to irrigation have survived better than their non-irrigation counterparts.

The Tigray Reginal State has given attention to small-scale irrigation development as a means of combating drought situation and improving household food security. Accordingly, 22 small-scale irrigation projects with a total irrigation area of 1,266 hectare of land have been developed in Woreda Hintalo wojerat since 1995.

In an effort to tackle the chronic problem of food insecurity in the country, the Ethiopian government is implementing a new agricultural extension package program targeted to achieve accelerated and sustainable growth in crop production. However, the adoption and effectiveness of the new agricultural technologies have been constrained by moisture stress, unreliable and poor distribution nature of the rain. The finding of this study shows that the use of small-scale irrigation can reverse this tendency in which 96.67% and 93.33% of irrigation households in both Gum-selasa and Shilena Small-scale irrigation schemes have reported, as they are users of fertilizer.

Generally the two irrigation schemes studied have positive impact on the income and food security status of irrigators. And the contribution of the schemes has been explained in the following areas:

The majority of irrigation households have been able to produce two times a year using the irrigation water. The main field crops grown using small-scale irrigation schemes in the study areas were maize and barley and the dominant vegetables were onion and tomato.

The survey revealed that Onion is grown by 76.67% and 75% of the irrigators in both Gum-selasa and Shilena schemes respectively and the reason why the production of onion is most preferred was:

- The local seed of onion is easily obtained
- Irrigation water application and field management of onion crop is relatively easier (easy to operate)
- Onion is less perishable crop and it is easy to harvest and transport as compared to tomato which is the second highly produced cash crop in the study areas.
- It withstands diseases as compared to other crops.

The production of food grain crops under irrigation cultivation per tsimdi/0.25 hectare was significantly better than the production under rain fed cultivation. The reason for high difference between the two production systems was that crops under rain fed are affected differently by shortage of rainfall.

The study also revealed that the mean income obtained in the year 2011, 2012 and 2013 from irrigation cultivation was higher than production gain under rain fed cultivation and the reason for this variation was irrigator farmers produce twice a year besides the output per hectare is higher in irrigated agriculture than in rain fed agriculture. .

The average income of three years study period obtained from irrigated food grain crop and cash crop production together constituted 74% and 76.8% as compared to other sources of income in Gum-selasa and Shilena SSI respectively. Besides the share of cash crop was significantly higher than any other income source.

Farmers in the study area have accessed to fertilizer because the district agriculture and rural development office supply fertilizer to both irrigators and non irrigator farmers.

Therefore, farmers be it irrigators or rain fed cultivators relay on fertilizers. Even though majority of the farmers use fertilizer to their plot, very few farmers do not use fertilizer because of financial shortage.

5.2 Conclusion

Today, the issue of increasing farm household's income is a serious concern especially in arid and semi-arid regions, which is vulnerable to climatic instability and frequent droughts. In these regions, there are usually little doubts about the need to use water for agriculture, where rain fed farming is a high risk enterprise to ensure stable production.

A brief historical account shows that irrigation has played a key role in enabling sustainable food production where it is well managed by lowering the risk of crop failure. Irrigation also helps to prolong the effective crop growing period in areas with dry seasons by permitting multiple cropping per year where only a single crop could be grown otherwise. Furthermore, irrigation reduces the risk of expensive agricultural inputs like fertilizers from being wasted as a result of crop failure caused by shortage of water.

Access to irrigation increases the opportunity for crop intensity and diversification, which increase cropping income. Irrigation is becoming a practice to increase total annual income for many households in the study area. In addition to their normal rain fed cultivation, irrigating households cultivate cash crops using small-scale irrigation. The main irrigated crops were onion, tomato, maize and barley. Irrigated crops (cereals) were selected due to household demand; appropriate for the climate and easy to apply irrigation respectively. Onion and maize were the major income source crops for irrigating farm households, respectively.

As briefly discussed in the main body of this study, Gum-selasa and Shilena SSI are found in one of the most drought-prone and food insecure areas in the region. In this regard, since irrigation is a long tradition in the study area, its role in increasing irrigator's income and its coping mechanism to mitigate the effects of draught is very significance.

The majority of irrigators' farmland is under rain fed cultivation and in majority 0.25 ha of farm land is cultivated by applying irrigation water. This is due to shortage of water as well as irrigation requires high amount of lab our (lab our intensive).

As compared to other household sources of income the average income obtained from irrigation agriculture accounts 71.5%, 74.4%, 76% in Gum-selasa and 70.2%, 74.73%, 78% in Shilena SSI

during the past three years. This may signify the need for smallholder irrigation development as a key draught mitigation measures and improvement of household income in the study area.

For instance, of the 60 farmers interviewed in Gum-selasa SSI, 80% (48 farmers) said that irrigation highly increased their access to basic needs while 20% (12 farmers) responded that irrigation moderately improved their income. Accordingly, in Shilena SSI, of the interviewed 60 farmers, 83.33% (50 farmers) said that the contribution of irrigation in increasing households access to basic needs (income) was high while 16.67 (10 farmers) responded that irrigation increased their income moderately. Therefore, the finding of this study shows irrigation significantly contributed to the increase in households' income and production in both study area.

With regard to the impact of irrigation development in the economic life of people in the study area, the result of the survey has shown that different economic linkages emerged that helped people inside and around the study area. There are different linkages created because of irrigation though they are in the infant stage of development. These linkages are production linkages, consumption linkages, investment linkages and employment linkages. These linkages prevailed either in the form of backward and forward modality or in one of it in each case. For instance, the production of cash crop created job opportunity for many land less young people that subsist as farm laborers. The increased income obtained by farmers as a result of irrigation created high demand for modern farm inputs and farm implements. Farmers demand for non agricultural products such as food oil, kerosene, salt, soap, sugar, cloths, etc. increased with the increase of their income from irrigation.

Development of well managed small scale irrigation system in draught prone regions as a vital task of increasing farm household's production and income requires the development of good infrastructures. Some of these infrastructures are the establishment of good input and output market information system and storage facilities.

As the study revealed there are some limitations in access to market information and storage facilities for perishable cash crops in the study area.

The cropping intensity in both irrigation systems is similar. i.e., in both irrigation systems more than 90% of vegetable production is concentrated on onion production that causes competition for market among producers. In most cases farmers do not have the power to bargain with traders since they deal individually. As a result, they remained price takers.

There is practice of inter cropping and crop rotation that contributed to efficient utilization and production efficiency in both study area.

In both schemes there are no organized marketing strategies in which farmers can combat with the negative effects of irrigation as a group.

The study revealed that the main problems of irrigation development in both schemes have been challenged by a number of constraints among which are lack of Storage facility, market problem for cash crop produce during harvest period, Water salinity and lack of skill training of irrigation are most prominent.

Currently, the TIgray Regional Government seems to consider smallholders irrigation development as a strategy to improve food security and contribute to overall growth of the local economy. The establishment of Water works construction enterprise as an independent government institution, which is responsible for the development of smallholder's irrigation systems is the indication for the attention given by the regional government. As a result investments in irrigation have been accelerated and many new irrigation dams and wells are flourished in addition to the existing ones.

Generally, the result of this study summarizes that given the limitations such as lack of storage facilitations, market problems for cash crop produce during harvest period (low price) and water salinity has removed or at least minimized, both irrigation systems can be vital instruments to increase farm household income by switching from low-value subsistence production to high value market oriented production. In order to attain this goal, integrated effort of different stakeholders and other relevant institutions is also very important. This is for the fact that the development of irrigation canals by itself cannot bring about a very significant change in increment of household income.

5.3. Recommendations

Based on the results of this study the following recommendations are forwarded

- **Improving the marketing system**

The production of high-value vegetable crops could be attractive business in agriculture if it could help farmers to obtain high returns from it. But this achievement is not only the result of good harvest. Market is the most important factor that determines whether to continue or quit the business. The government should not leave farmers agricultural products to the interplay of

market forces since it is often affected by the fluctuating market price. In this regard, there should be practically applied policies that support farmers to get reasonable price for their perishable vegetable produce to stay and invest more in the sector. Relevant and timely information has increasing value as the business of irrigation becomes more complex and volatile. Therefore, establishing effective information system can do much in improving time and situation specific information.

- **Ensure faire price for agricultural inputs**

Prioritize the development of low price inputs to increase crop productivity, price bargaining power and profitability of the irrigators is mandatory.

Even though, the government tried to provide agricultural in puts at reasonable price, some farmers still are complaining on the price of agricultural inputs.

Therefore the government, cooperative organizations and private organizations should give attention on the supply of these inputs on low price, on time and in adequate amount.

Further studies of the marginal returns to these inputs compared to their costs could also facilitate development of approaches to increase input use, when appropriate.

- **Provision of storage facilities**

Availability of faire price and product market is of paramount importance to the success of irrigated farming. However, majority of the irrigating farmers in the study area replied during the survey time is that they got low price during harvest period. Therefore, government and other development sectors should give due emphasis to the development of good storage facilities to protect irrigating farmers from unfair price during the harvest period.

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APPENDIX-A
QUESTIONNAIRE

To be filled by household heads who uses irrigation agriculture.

INTRODUCTION

Dear respondent,

The objective of this household survey questionnaire is to assess the contribution of small-holders irrigation in household income and production in Hintalo-wojerat Woreda.

The study focuses on farm household's resources and income, irrigation practices and support issues. Therefore, your active participation and genuine responses is very important in meeting the intended objectives of the study. I kindly request your active cooperation in responding to the questionnaires. The study is fully for academic research purpose and any information you provide will be kept confidential.

INSTRUCTION

Give your answer by circling the appropriate answer from the choices given under each questions.

Survey area (kebele) _____

Enumerator _____

Date _____

Supervisor's name_____ Signature_____

Thank you!

I. Personal Data

1.1. Indicate the household size _____

1.2. Sex composition of the household 1= Male ____ 2= Female ____ Total ____

1.3. Age composition in the household

1= below 12 years 2= 12-17 years 3= 18-65 years 4= above 65 years

1.4. Literacy level of the household 0= illiterate ___ 1= read and write only ___

2= Primary education (grade 1-4) ___ 3=Primary education (grade 5-8)

4=Secondary education (grade 9-12) ___ 5= diploma and above ___

1.5. Marital status of the household head 1= married 2= widowed 3= divorced 4= unmarried

1.6. Ethnic background 1= Tigraway 2= Agew 3= others\specify

1.7. Religion 1= Orthodox 2= Islam 3= Protestant 4= Catholic

5= others\specify

1.8. How do you categorize your family labor for your irrigated land activities?

1= small 2= enough 3= large 4= excessive

1.9. Which income source is the major contributing activity? (Rank them)

1= irrigated agriculture 2= rain fed agriculture 3= masonry work 4= off-farm 5=others\specify

II. Household Resources and Income

2.1. Total land size _____ (you can use hectare or local measurement tsimdi=0.25 hectar)

2.2. Irrigable land _____

2.3. Irrigated land_____

2.4. Land under rain fed _____

2.5. Patterns of rain fall in the area 1= enough 2= moderate 3= low

2.6. What kind of crops do you produce using irrigation? 1= grain 2= vegetables 3= fruits

4= 1&2 5= 1&3 6= 2&3 7= all 8= others(specify) _____

2.7. How was your agricultural production for the last three years?

1= excess for annual household consumption

2= sufficient for annual household consumption

3= sufficient for six months only

4= sufficient for less than six months

5= others (specify) _____

2.8. Annual Income from Grain Production

Crop Item	Irrigation									Rain fed								
	Area Cultivated in hectare			Total Production in quintal			Total income (Birr)			Area Cultivated in hectare			Total Production in quintal			Total income (Birr)		
	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Wheat																		
Maize																		
Sorghum																		
Teff																		
Barley																		
Pulses																		
Oilseeds																		
Finger millet																		
Spices																		
Others\specify																		
Sub Total																		

2.9. Annual Income from Vegetable Production

Crop Item	Irrigation									Rain fed								
	Area cultivated in hectare			Total Production in quintal			Total income (Birr)			Area cultivated in hectare			Total Production in quintal			Total income (Birr)		
	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013	2011	2012	2013
Onion																		
Tomato																		
Potato																		
Pepper																		
Cabbage																		
Garlic																		
Carrot																		
Others\specify																		
Sub total																		

2.10. Do you apply manure on your farmland? 1= yes 2= no

2.11. If your answer is no, why? 1= shortage of manure 2= alternative use of manure

3= labor shortage to handle & transport manure 4= others\specify_____

2.12. Do you apply fertilizer on your farmland? 1= yes 2= no

2.13. If no, why? 1= cash shortage 2= fertilizer is not available

3= recommendation rate is not profitable

4= others (specify) _____

2.14. Have you ever used an improved seeds? 1= yes 2= no

2.15. If you do not ever used improved seeds, why?

1= too expensive to buy 2= not available 3= not better than the local ones

4= not heard or not aware 5= others (specify) _____

2.16. Have you ever used pesticides? 1= yes 2= no

2.17. If not, why?

1= too expensive 2= not available 3= not heard or not aware

4= others (specify) _____

III. Issues Related to Irrigation Practices

3.1. If you are not irrigate all of your irrigable land, why?

1= shortage of farm implements 2=shortage of farm inputs 3= shortage of labor 4=lack of demand for your produce at market 5= lack of extension service 6= getting sufficient produce by rain feed agriculture 7= others\specify

3.2. How many times you produce annually by applying irrigation? _____

3.3. What are the major agricultural cash crops you produce using irrigation?

1= Onion 2= Tomato 3= Potato 4=Pepper 5=Cabbage 6=Garlic 7=Carrot 8= Others\Specify

3.4. Why do you prefer to grow such cash crops? 1= better price 2= good production

3= easy to operate 4= high disease tolerance 5= seeds availability 6=nonperishable

7= others (specify) _____

3.5. If you are not producing cash crops what is your reason?

1= lack of market 2=lack of pesticides 3=lack of storage facilities 4=lack of selected seeds

5=others\specify

3.6. Which of the food grain crops do you produce through the use of irrigation?

1=Wheat 2= Maize 3= Sorghum 4= Teff 5=. Barley 6=Pulses 7= Oil seeds 8=Finger mille 9=Species 10=Others\specify

3.7. If there are any, why do you choose them?

1= household demand 2= requires less labor 3= appropriate for the climate

4= easy to apply irrigation 5= others (specify) _____

3.8. What positive outcomes of irrigation have you observed? (Rank in order of importance).

1= Change in the number of meals eaten per day

2= Change in the variety of food eaten.

3= Change in the amount of money spent on education.

4= Change in the amount of money spent on health.

5= Change in the amount of money spent on clothing.

6= Change in the ability to cope with draught.

7= Change in coping strategies during times of food shortage.

8= Reduce in crop failure and increase production.

9= Change in the amount of products sold for income.

10= Increase employment opportunity during irrigation season.

11= Diversification of crop grown.

12= others (specify) _____

IV. Credit, input and extension service supports in production

4.1 Credit support service

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

0 = No 1 = Yes

2. If yes, why?

1= to purchase oxen 2= to purchase farm implements

3= to buy modern farm inputs like fertilizers 4= to construct house 5= to buy improved seeds

6= others (specify)

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

0 = No 1 = Yes

4. What is the source of your credit?

1. = Banks

2. = Friends\relative

3. = Traders

4. = Microfinance

5. = Saving and credit cooperatives

6. = Other forms of cooperatives\specify

5. Is credit timely available for agricultural commodities development?

0 = No

1 = Yes

6. Is credit adequately available for agricultural commodities development?

0 = No

1= Yes

4.2 Extension services

1. Do you receive any sort of extension services from woreda agricultural office in 2004 e.c?

0 = No

1 = Yes

2. If yes, during which operation?

1= land preparation ____ 2= planting/transplanting ____ 3 = weeding ____

4= applying agro chemicals ____ 5= watering ____ 6= harvesting ____

4.3 Access to other Services

1. Do you get market information about price conditions of agricultural inputs and out puts?

0 = No

1 = Yes

2. If yes indicate the source of information.

1= personal 2=extension agents 3= marketing agency 4= cooperatives 5= others\specify

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

1= take produce to the market. Where? _____

2= traders buy from the field.

3= contract with an institution.

4= others (specify) _____

4. How far is the market you mentioned from your plot? _____kms.

5. How do you sell your produce?

1= as an individual 2= as a member of an informal group

3= as a member of cooperative

4= others (specify) _____

6. Do you face a problem in selling your produce? 0= no 1= yes

7. If your answer is yes what type of problems? 1= low price 2= lack of transport

3= low demand for the produce 4= others (specify) _____

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

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

9. What are the prices of your agricultural products at local markets during the non-harvest periods? 1= very cheap 2= cheap 3= competitive 4= expensive

Thank you!

Any comments:

_____

_____

_____

_____

APPENDIX- B

CHECKLISTS

I) Checklist for focus group discussion

1. When did your Tabia start irrigated crop cultivation?
2. What is your general opinion on the contribution of irrigated agriculture to household income?

3. What are the major crops produced in your woreda/Tabia through irrigated agriculture?

4. How do you evaluate the price and demand for your irrigated production?

5. From which source do you get your major income?

6. What factors do affect your irrigated income and how?

7. What economic effects do you observe as a result of irrigation agriculture?

8. What benefits do you get from irrigated agriculture?

9. Which do you prefer irrigated agriculture or rain fed agriculture? Why?

10. From your experience irrigated or rain fed is more productive per hectare?

11. What are the major challenges that inhibit the optimal utilization of the irrigation schemes?

11. What is the contribution of irrigated crop production in facilitating households' access to different services(Health service, Education , input supply and others)

12. What is the contribution of irrigation agriculture to livestock rearing?

13. According to your opinion what are the socio-economic benefits of irrigation practices in your woreda?

14. What do you suggest for the improvement of your irrigation performance in the future?

II) For key informants

1. What is the contribution of small scale irrigation in improving the livelihood of farm households in general and farm household's income in particular?

2. What were important coping strategies to facilitate irrigation in the area?

3. According to your opinion what is the contribution of the small scale irrigation for the local and regional income growth?

4. What were the trends of income related to irrigation in the past three years?

5. What do you think are the major benefits of irrigation to farm households?

6. What are the major factors that facilitate irrigated agriculture?

III) For Woreda Irrigation Office

1. What are the socio-economic contributions of small scale irrigation for the Woreda?
2. What supports do the woreda agriculture office provided to the irrigation user farmers?
3. What do you suggest for the improvement of small scale irrigation in the Woreda?
4. What are the major factors that promot or hinder irrigated agriculture?
5. How do you evaluate the contribution of irrigation to household's income in your woreda