JIMMA UNIVERSITY

INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

HYDRAULICS AND WATER RESOURCE ENGINEERING

HYDRAULIC ENGINEERING MSC PROGRAM

SMALL-SCALE IRRIGATION AND HOUSEHOLD FOOD SECURITY: A CASE STUDY OF TWO IRRIGATION SCHEMES IN LALIBELA WOREDA OF NORTH WOLLO ZONE,AMHARA REGION.

A THESIS SUBMITTED TO SCHOOL OF GRAGUATE STUDIES OF JIMMA UNIVERSIY IN PARTIAL FULIFILLMENT OF THE REQAUREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN HYDRAULIC ENGINEERING STREAM.

By: TIZAZU BEKELE

NOVEMBER, 2015

JIMMA, ETHIOPIA

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NOVEMBER, 2015

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

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Candidate Signature Date

This thesis has been submitted for examination with my approval as a university supervisor

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Advisor Signature Date

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Co-Advisor Signature Date

ABSTRACT

This study aims to examine the role of small-scale irrigation development to assure household food security in drought prone Woreda of LalibelaNorth Wollo Zone, Amhara region. Its main objective being the study of the impact of irrigation on household food security, paying particular attention to its contribution towards increasing agricultural production, household income and the potential to reduce dependency on food assistance. The study also looks at the management and operation processes of irrigation schemes and its role to performance level of schemes.

To serve these objectives, household survey, focus group discussion and key informant interview were used to collect data at household and individual level. Annual household production, income generated, asset owned and other socio-economic data were collected using structured questionnaire with the help of locally recruited and semi-trained enumerators. Background information of the study area, irrigation potential, food aid, beneficiaries, and market survey data were gathered from concerned government line departments and institutions operating in the Woreda.

The finding of the study highlights the positive impact of irrigation development in that it helps to sustain, diversify and increased agricultural production. Irrigation enables farmersto generate more income and maintain productive assets like draught oxen. The study alsorevealed that irrigation promotes the use of agricultural inputs through supply of waterduring the dry season and when the amount and distribution of the main rain is found to beinadequate. Such opportunities of irrigation improve food availability and food securitysituation of irrigation households.

The result of this study also shows that households with access to irrigation have been ableto double their annual income through the production of high value horticultural crops.Irrigation is providing gainful self-employment for participants and improving householdaccess to marketable food. Moreover, households could diversify their diet composition andfound at a better nutrition status due to diversified food sources produced through the use ofirrigation.

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LIST OF ACRONYMS

ADLI Agricultural Development Led Industrialization

DADevelopment Agents

EGS Employment Generation Schemes

EPRDF Ethiopia People Republic Democratic Front

ESRDF Ethiopian Social Rehabilitation Development Fund

EVDSA Ethiopian Valley Development Studies Authority

FAO Food and agricultural Organization (of UN)

FDRE Federal Democratic Republic of Ethiopia

HH Households

IDD Irrigation Development Department (of the former MOA)

IFAD International Fund for Agricultural Development

LWF Lutheran World Federation

LWAO Lalibela Woreda Agriculture Office

MEDC Ministry of Economic Development and Cooperation

MOA Ministry of Agriculture

MWR Ministry of water resources

MOARD Ministry of Agriculture and Rural Development

MOFED Ministry of Finance and Economic Development

NGO Non-Governmental Organization

ONCCP Office of the National Committee for Central Planning

SCF-UK Saves the Children Fund- United Kingdom

WUA Water Users Association

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1. INTRODUCTION

1.1Background

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 the rural land proclamation was introduced in the country. Following the rural land proclamation, the irrigated private farms were nationalized and converted to state farms by the Derg regime.

By early 1985 in Ethiopia, some 7.7 million people were suffering from drought and food shortages. More than 300,000 died in 1984 alone, more than twice the number that died in the drought a decade before. Before the worst was over, 1 million Ethiopians had died from drought and famine in the 1980s. The recurring cycle of drought produce the need for small scale-irrigation development expansion to other parts of the country to address drought and food shortages, and the need for more food for the internal market.

Agricultural growth is not produced by passive 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 for agricultural growth to occur, 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).

The current government has undertaken various activities to expand irrigation in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable development.

Thus, irrigation development, particularly small-scale irrigation is planned to be accelerated (MOFED 2010).

The study area, North Wollo Administrative zone is one of the eleven zones of Amhara National Regional State. It is now divided in to nine Woredas and 257 Kebele Administrations having a total population of 1.4 million people.

Like other parts of the region, agriculture is the main means of livelihood for the population in North Wollo both in terms of crop production and livestock. Farming is almost totally dependent on rain fed agriculture. Customarily, the farmers produce biannually with the short rain of February – March (*Belg)* and main rain of June-August (*Meher*). But *Meher* is the dominant season of production in most parts of the zone. Under normal rain years, majority of the farmers in most cases produces adequate amount to meet their food requirement. Unfortunately, agricultural production and productivity in the zone has severely been affected by recurrent drought and rain short falls. Such unfavorable climatic conditions often resulted in acute decline in the food security status of the people. Thus, in North Wollo Zone irrigation under small holders' management is being undertaken to attain this objective.

On the other hand, there is some river water potential available especially in the KollaWoredas of Lalibela, Habru and Kobo for increasing productivity of rain-fed agriculture. This is possible through the diversion of the perennial rivers and provision of adequate and sustainable irrigation water to the vast irrigable land during the dry season and when the amount and distribution of the main rain is found to be inadequate for agricultural purpose.

Irrigation development is one of the components of water resource development. Irrigation schemes can be classified in to small, medium and large scale depending on their role, organization, the size of the area developed and the systems used. On the

other hand, irrigation schemes can also be classified in to traditional and modern (formal) schemes. The developers can be private investors, public sectors or communities (Sing and Misra1960). Therefore, this research work deals with the role of small-scale irrigation under small holders' management in alleviating food insecurity problem in Lalibela Woreda of North Wollo Zone

1.2Statement of the Problem

For Ethiopia, ensuring food security stands out as the most pressing agenda now and for the coming decades. It has also been indicated that both chronic and transitory problems of food insecurity are severe in Ethiopia. There are many interrelated and complex factors that have contributed for the worsening situation of human welfare in the country. Among other things, inadequate and variable rainfall, high man land ratio and soil degradation, civil conflict, faulty development policies of the past regimes and overall poor performance of the national economy are said to be the major ones.

Since the 1970s, recurrent droughts, unreliable and poor distribution characters of rainfall have resulted in crop and pasture failure. These have in turn brought about food shortage and famine, particularly in the northern part of the country. North Wollo administrative zone is one of the drought prone areas of northern Ethiopia. In the recorded history, drought induced famine has been more severe in Wollo region than the others.

In areas where rainfall is unreliable, irrigation development, provision of adequate and sustainable water for agricultural purposes is a viable option to secure food production. In some pocket areas of North Wollo, a traditional irrigation system has been practiced since early times. There are also few recently upgraded irrigation schemes with the prime aim of ensuring household food security and improving the living standard of the farming community. So far, there are only limited studies on the socio-economic impact of smallholders' irrigation development in North Wollo Zone in particular and in the Amhara region in general. Therefore, this study will look at on the contribution of small-scale irrigation to household food security, taking two irrigation schemes as a case study in Lalibela Woreda of North Wollo Zone.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study is, to examine the overall socio-economic impact of small-scale irrigation development and its contribution to ensure household food security in drought prone localities of Lalibela Woreda of North Wollo Zone.

1.3.2 Specific Objectives

The specific objectives of the study are:

1. To assess the roles and contribution of irrigation schemes towards increasing agricultural production, income and the potential to reduce households' dependency on food aid.
2. Review the management and operation processes of irrigation schemes and its role to good and poor performance of the schemes.
3. To identify major problems and constraints of irrigation development in the study area.

1.4 Significance of the Study

Several studies have been conducted on the problems of food insecurity and reports are available on the evaluation of some agricultural programmers (like extension packages) since the 1960s. Different studies have also revealed that the majority of the Ethiopian population in almost all regions of the country is severely affected by chronic and transitory food insecurity.

Irrigation development is one of the many components in the agricultural sector that has been promoted in drought prone highland areas and in the vast lowland areas of the country in order to increase and diversify agricultural production. Since the beginning of the 1990s, design and construction of small-scale irrigation infrastructures like diversion weir, main canals and field layouts have been undertaken by regional states. So far, it has been reported that most of the newly upgraded schemes are poorly performing due to problems related to weak management and operation of schemes and low level of beneficiary

participation in the development process. Thus, this study is designed to assess such aspects of irrigation development inLalibela Woreda of North Wollo Zone Amhara region.

1.5Research Question

For a specific study of small-scale irrigation schemes linking with the issues of food security, a number of questions have been raised and an attempt was made to address in the study report. The major research questions are:

1. What is the position of irrigators' in terms of production, income and dependence on food aid when compared with their non-irrigation counterparts?
2. How has the management and operation of the schemes been undertaken?
3. What are the major problems and constraints of irrigation development in the study area?

1.6 Scope and Limitation of the Research

This research was made to assess the socio-economic impact of small-scale irrigation and its contribution to household food security in drought prone Woredaof Lalibela. However, the study has many limitations.

Household survey by itself is complex and to get reliable data especially on household land holding, volume of production, income, number of livestock as well as other variables which have close economic and social implications are not always free from error. From their past experiences, people in the study area expect other land distribution practice and have responded in a different way. Moreover, some of them were very suspicious about the recent unproved agenda of resettlement program. Peasants of the area also used to see and understand everything in light of relief assistance.

As a result, they were reluctant to give information on their socio-economic status and they have often under-reported what they have actually owned. However, different methods such as focus group discussion and informal interviews were used to crosscheck the data gathered through questionnaire interview.

Another problem faced during the data gathering was unavailability of the household heads in their home during most of the day time since they were busy cultivating and sowing their irrigation land. The only way of reaching the farmers was to visit them on their farm and they were not willing to spend required times on the interview.

Irrigation is capital intensive development intervention. However, due to lack of data on the cost of the development, it was not possible to undertake cost-benefit analysis of irrigation projects in this study.

Due to financial and time constraints, the researcher had a relatively short stay in the study area. As a result, not all aspects of the household in the area were dealt with. Moreover, transport facility and other necessary research inputs were major constraints in this research.

1.7Organization of the Research

The research is organized as follows. Chapter one is an introduction of the study, which containsstatement of the problem, research objective, research question and scope and limitation of the paper.Chapter two gives an overview of the literature on irrigation development and food security.Chapter three contains the general background information about the study area,description of sample irrigation schemes and material and methodology. Chapter four presents major findings and discussionof the survey on small-scale irrigation and household food security. And in chapter five asummary and conclusion is made by addressing the main issues, problems and findings of the study.

2. LITRATURE REVIEW

2.1 General Overview of Water Resources and Irrigation Development

Water is a renewable natural resource, which exists in the form of surface water (in Ocean and Lakes, rivers and streams) and ground water. Water is a mobile natural resource that is found in different forms and qualities. Among other forms, fresh waters are indispensable for the sustenance of life and of vital importance to all socio-economic activities.

water has contributed enormously for human civilization and socio-economic development since early-recorded history. For instance, the first urban center appeared in Mesopotamian river basin and Nile Valley before 3,500 B.C (Sjoberg 1996). This was mainly due to the river water for domestic use, transportation and irrigation agriculture. To date, three broad components of water resources development can be mentioned. These are water for domestic use (drinking, food preparation, cleaning, etc), irrigation development and hydropower production. However, the concern of this research is on irrigation development with a special emphasis on small-scale irrigation schemes.

Irrigation development is a special case of agricultural development in which technology intervenes to provide control for the soil moisture regimes in the crop root zone to achieve a high standard of continuous cropping (EVDSA 1996). The production of crop depends, among other things, on such climatic factors as temperature range, length of growing season and the amount, frequency and distribution of rainfall. Endeavoring to control the variable aspects of these factors, farmers discovered that the moisture plants need could be supplied by irrigation. This knowledge enabled human beings to become independent of the vagaries of natural rainfall and enabled them to grow crops in arid and semi-arid regions. Therefore, applying water to soil for plant is irrigation.

Some 17 per cent (250 million hectares) of the world's agricultural land are irrigate d and account for more than one-third of global food production (Smith, 1988). Of these almost three-quarters of the total irrigated area is found in Asia. Many studies suggest that large investments in irrigation have been an essential element in increasing food production to sustain the ever-growing population. To meet food requirements by 2020

(world population is estimated to reach 8 billion), FAO (1995) estimated that food production from irrigated area s will need to increase from 35 % in 1995 to 45 per cent in 2020. This indicates that access to water for irrigation will become an issue of global concern and competition in the future, especially in the arid and semi-arid regions of the world.

When we look at the situation in Africa, frequent drought conditions and ever-increasing population in most countries have attributed to the increasing expansion of irrigation farming since the 1960s. (FAO 1986) estimated that the total irrigation potential for Sub-Saharan Africa is about 33.6 million hectares. Regarding the total irrigation area FAO (1986) indicate d that Africa south of the Sahara irrigates some 5 million hectares 1990 and the irrigated area has been growing at a rate of 5 percent per year in 1965-74 and less than 4 per cent a year in 1974-1982. It was also estimated by FAO (1986) that irrigation development in Sub-Saharan Africa contributes 10 per cent of the region's cereal supplies.

Ethiopia has an estimated annual surface runoff close to 122 billion cubic meter excluding ground water (MoWR, 1993). However, 80-90 per cent of the Ethiopia's water resource is found in the four river basins, namely, Abay, Tekeze, Baro-Akobo and Omo Gibe in the west and southwestern part of the country where the population is no more than 30 to 40 per cent. On the other hand, the water re source available in the east and central river basins is only 10 to 20 per cent, whereas the population in these basins is over 60 % of the total (MoWR, 1993).

The total irrigation potential of the country is estimated at 3 million hectares and the total coverage of irrigation in the country is also estimated to be only 168,000 hectare s (MOA, 1993). It is also estimated that out of the total annual production of cereals in the country, only about 3 per cent is produce d through irrigation (ONCCP, 1990).

2.2Irrigation Development

Irrigation is generally defined as the application of water to the land for the purpose of supplying moisture essential to plant growth. It is an age-old art. Irrigation was practiced for thousands of years in the Nile Valley. Egypt claims to have the world's oldest dam built about 5000 years ago to supply drinking water and for irrigation. At that time basin irrigation was introduced and still

plays a significant role in Egyptian agriculture. According to Zewdie et al. (2007) irrigation has been practiced in Egypt, China, India and other parts of Asia for a long period of time. India and Far East have grown rice using irrigation nearly for 5000 years. The Nile valley in Egypt, the plain of Euphrates and Tigris in Iraq were under irrigation for 4000 years. Irrigation is the foundation of civilization in numerous regions. Egyptians have depended on Nile's flooding for irrigation continuously for a long period of time on a large scale. The land between Euphrates and Tigris, Mesopotamia, was the breadbasket for the Sumerian Empire. The civilization developed from centrally controlled irrigation system (Schilfgaard, 1994).

Evidence also shows that irrigation in China was begun about 4000 years ago. There were reservoirs in Sri Lanka more than 2000 years old. As far back as 2300 BC, the Babylonian Code of Hammurabi provided that 'If anyone opens his irrigation canals to let in water, but is careless and the water floods the fields of his neighbor, he shall measure out grain to the latter in proportion to the yield of the neighboring field.' Other indicator for irrigation development is found in the stony-gravel limestone desert of the Negev area in Israel. Remnants of these ancient irrigation systems date back from the Israelite period (about 1000 BC) and from the Nabattean Roman-Byzantine era (300 BC to 600 AD). In the absence of permanent water sources, the ancient farmers developed 'runoff' farm systems that used sporadic flash floods for irrigating (Shanan, 1987).

Ethiopia has a long history of traditional irrigation systems. Simple river diversion still is the dominant irrigation system in Ethiopia. According to Gebremedhin and Peden (2002), the country's irrigation potential ranges from 1.0 to 3.5 million hectares but the recent studies indicate that the irrigation potential of the country is higher. According to Tilahun and Paulos (2004) as cited by Awulachew et al. (2010), estimates of the irrigation potential of Ethiopia may be as large as 4.3 million hectares. Traditional irrigation schemes cover more than 138,000 hectares whereas modern small-scale irrigation covers about 48,000 hectares. The total current irrigation covers only about 6% of the estimated potential land area.

According to the MOA (2005) and Awulachew et al. (2007), Amhara region has 770,000 hectares of irrigation potential. Different development activities have been underway to utilize these resources. Currently, there are 310 irrigation schemes operating in the Amhara region. The

irrigation schemes developed cover an irrigated area of 8,469 hectares with 17,443 beneficiaries. Of these total irrigated areas, 5,719 hectares are from small-scale and 2,751 are from medium-scale irrigation schemes.

2.3 Classification of Irrigation Developments

Classification of irrigation schemes in to large, medium and small-scale is often applied with reference to area irrigated, scale of operation and type of control or management. However, the consideration of such criteria to draw the line between "Large" and "Small" scale irrigation varies considerably from country to country. For instance, in India an irrigation scheme of 10,000 hectares is small while in Ghana the largest irrigation scheme is 3,000 hectare (Smith 1998). In relation to the specific water control technology used, the same author indicated that tank irrigation, small dam irrigation and shallow or deep tube well irrigation all are simply termed as small-scale irrigation schemes.

In most cases, large schemes have formally been planned and are typically managed by government departments delegated with the necessary authority for fairly comprehensive control. Most small-scale irrigation, however, has arisen indigenously or informally under loc al responsibility and operated and controlled by the local people in response to their local needs.

In the 1960s and 1970s, the initial investments in irrigation development were directed towards large -scale hydraulic structures irrigating thousands of hectares of land. During those de cades, the rapid irrigation developments were implemented under large public development programmers and provided an attractive stimuli for lending by various investment agencies such as the World Bank, Asian Development Bank (ADB) and other regional banks. However, once completed, the costs of operation and management of the irrigation systems were to be covered from national budget resources that often disposed of insufficient funds. The result has been poor performance and rapid deterioration of the irrigation infrastructure that has required recurrent investments in rehabilitation. In the latter decades, therefore, cost, performance and environmental constraints have increasingly marginalized large-scale irrigation projects (FAO 1995).

Dams and reservoirs have inundated arable and pastureland and often resulted in force d population displacement. Water inundation also leading to the loss of biodiversity and has frequently been accompanied by serious health hazards like the incidence of malaria and schistosomias. Other environmental hazard caused by large-scale schemes is siltation and the concomitant loss of valuable land. The incidence of siltation and water logging is often associate d with poor water management and inadequate drainage system of irrigation schemes.

With regards to operation, management and performance of large-scale irrigation schemes in Africa, FAO (1987: 56) identified the following special weaknesses:

- "over sizing government and administrations, leading to excessive recurrent costs;
- Lack of management and technical skills;
- Lack of consistent policy and failure to plan for the medium and long term; delegate authority as well as responsibility;
- Lack of foreign exchange for such essentials as fuel, spare parts and replacement machinery;
- failure to give adequate return to farmers, leading to their a abandoning the schemes."

Due to such problems in large-sc ale schemes, small-scale irrigation has been increasingly recognize d as a valid and attractive option in irrigation development both by government and donor agencies.

In a more practical sense, small-scale irrigation developments are concentrate d with the upgrading of traditional community irrigation or village irrigation systems, newly designed and constructed irrigation systems and ground water and pump development (Smith 1988). In highland area s like Ethiopia, where water is delivered through gravity, small-scale irrigation schemes concern the upgrading of irrigation works, where the simple diversion structures constructed by traditional communities with local means such as stone and brushwood have been replaced by small concrete or masonry weir, which divert water in a more effective and

durable way. Such upgrading of irrigation works are the major functions of all river diversion irrigation projects that have been undertaken in different parts of Ethiopia.

An important aspect in the promotion of small-scale irrigation has been to increase farmers' involvement in the planning, implementation, operation and management of irrigation systems. The participation of farmers as direct beneficiaries in the construction of the schemes and their responsibility in the operation and management could considerably reduce development and management costs and improves performance. A study conducted on the socio-economic impact of ten smallholders' irrigation schemes in Zimbabwe (FAO, 2000) reported that projects that are planned with farmer participation perform better than that are planned by experts on their own. The study further noted that projects that are viewed by farmers as being their projects perform better than projects that are viewed by them as belonging to the government.

2.4 Water and Agriculture

Water, soil, air and sunshine are the four main determinants for plant growth. Therefore, water is essential to plant-growth and crop-production (Widtose, 2001). All sectors depend on water. Water is important for agriculture, household consumption, industry, hydropower, navigation, fisheries, recreation, and ecosystems. Without water there is no food production. When there is adequate supply of water, crops grow best and produce most.

Water is a basic need for human beings and animals. It is essential for their metabolic processes. Livestock water requirements are mainly provided by direct water intake and partly by the moisture content of their forage. Livestock production requires large quantities of forage. The production of forage requires substantial amounts of water. Therefore, water is vital for all agriculture types.

According to Dupriez and De Leener (2002), the sources of water for crop production are rainfall and irrigation water. The two types of agriculture seen from the perspective of water management are:

Rain fed cultivation is agricultural production of crop depending entirely on the rain. It relies on the rainfall timing and distribution. Rain fed farming is characterized by plateau cultivation and

dry land cropping. Rain fed farming is mostly practiced during one growing season, but in some areas two growing seasons (bimodal production) are possible.

Irrigated cultivation is agricultural production using irrigation water in addition to rainfall. Irrigated crops benefit from man-made watering with the help of water pipes, canals, reservoirs and pumps. The source of irrigation water is surface water or groundwater. Surface water is obtained in ponds, lakes, rivers and seas whereas groundwater is obtained underground in liquid or vapor state (Dupriez and De Leener 2002).

2.5 The Role of Irrigation in Alleviating Food Insecurity Problems

In many drought prone countries, including Ethiopia, there has been an optimistic view regarding irrigation development as a strategy to sustain agricultural production and ensure food security. In such countries, the key constraint on further increase in agricultural production is the scarcity of water. Therefore, national planners are strongly attracted to irrigation as a means of supporting future food strategies. In this regard, Elahi (1988) pointed out that for countries with arid and semi-arid climates, the luck of uncertainty about rainfall along with rising demographic pressure on rain fed land, would strongly be pointed to irrigation as a prime candidate to support future food strategies in the medium and long term. Similarly, Dessalegn (1999) stated that, where rainfall is insufficient and unreliable, rain fed agriculture cannot fully support food production, investment on water management schemes will help stabilize agricultural production and promote food security.

The need for irrigation development in drought prone regions is also promoted by many international development organizations. For instance, IFAD (1985) indicated that small-scale irrigation schemes would stabilize agricultural production system and assure food supply even in years with inadequate rainfall and increase the overall level of crop production in years with normal rainfall.

Another advantage of irrigation is that the possibility of intensification of agricultural practices, especially in areas where arable land is a scarce resource. Irrigation provides the means of maximizing production with double or multiple cropping, taking full advantages of modern technologies and high yielding crop varieties. Moreover, irrigation provides farmers an

opportunity to grow high value crops like vegetables and fruits that require year round and generous supply of water to grow. Such diversification of agricultural products will ensure reliable income source to the farming community.

The available literature on the socio-economic impact of small-scale irrigation development in some African and Asian countries generally show that irrigators have been found in a better position in terms of income, nutritional status and standard of living than their non-irrigation counterparts. For instance, in India Sing and Misra (1960) compared the Sarda canal irrigation and non-irrigating villages and made the following observation: (as cited in FAO, 2000).

- ✓ "Gross farm output per acre is on the whole 8.6% higher in the canal irrigated villages than outside;
- ✓ The crop produce as distinct from the total farm output is 5.5% more with canal irrigation than without, mainly due to the cropping pattern under irrigation incorporating cash crops;
- ✓ The value of crop produce sold per acre is 48% higher in the canal-irrigated area than outsides;
- ✓ Total inputs per acre are 3.7% higher in terms of quantity in the canal irrigated area than outside, indicating more intensive farming under irrigation;
- ✓ Payment to outside labor, including casual and permanent farm labor is about 21% more in irrigated areas than outside."

The above study clearly shows the benefits from irrigation in terms of improved crop productivity, income source and employment creation to the community and gives better chance to ensure household food security.

FAO (1997) also reported benefits from smallholder irrigation. In the socio-economic impact assessment of Hama Mavhaire, Hoyuyus and Nyaitenga irrigation schemes in Zimbabwe, it is reported that:

"*Farmers' incomes from irrigated agriculture are significantly higher than Incomes from dry land farmers. The report also indicated that levels of Inputs in terms of quantity are higher in*

irrigation schemes than in dry land Areas, suggesting that there is more intensive crop production in irrigation schemes than in dry land agriculture".

In other African country, in the Gambia, in the study of an irrigation scheme in the village of Chakunda, Webb (1991) gave the following benefits of irrigation: (as cited in FAO 2000).

- "Increased income that was translated into increased expenditure, investment, construction and trade;
- Backward and forward linkages: traders were reportedly coming to purchase irrigation produce (rice) and in turn sell cloth, jewelry and other consumer items;
- Increased material wealth: at the village level, this was in the form of construction of a large mosque built through farmers' donations and an improvement of the village clinic. At household level, increased wealth could be seen in 55 houses built in the village, fourteen with corrugated metal roofing."

When we see the situation in Ethiopia, empirical studies on the economic validity and socio economic impact of smallholders' irrigation development are very limited, except pronouncing some possible benefits of water resource development. The only practical observation available to the researcher was a study undertaken by FuadAdem (2001) on small-scale irrigation and household food security on an irrigation scheme found in central Ethiopia. In this study, he has tried to examine the impact of cash crops production (possible to grow through irrigation) on the food security status of irrigators. He also made comparative observation on socio-economic situation between irrigators and their non-irrigation counterparts. As a conclusion, he has reported that many of the people who have been regular beneficiaries of periodic cash crop production are now more income secured and have better access to food.

Moreover, a study conducted by SCF /UK/ (1999) on the North Wollo East plain Food Economy Zone reported that irrigators can plant three times per year and in most cases the production serves as a valuable source of income and the majority of the farmers who have irrigation plot have been categorized under rich wealth group in the community. Generally, all the available evidences show that irrigation development is a viable option of rural development in order to reduce poverty and ensure household food security.

2.6 Irrigation Development in Ethiopia

Ethiopian farmers have practiced agriculture since earliest times using the technology sufficient to sustain food supplies of the then low population level. To date agriculture forms the bases of the Ethiopian economy contributing up to 50 % of the GDP, 90 % of total export earnings and providing a livelihood for 80 % of the population. Though agriculture is the major economic sector, its production is largely subsistent and predominantly rain-fed and as a result it has suffered from recurrent drought and unreliable rainfall.

In most parts of Ethiopia, production from rain-fed agriculture is highly fluctuates corresponding to the amount and distribution of rainfall. When there is too little rainfall or uneven distribution pattern, crop failure is certainly to come. In this regard, Webb and VonVraun (1994) estimated that a 10 per cent decline in rainfall below the long-term national average would result in a fall in all cereal yields by an average of 4.2 %. Such a failure in agricultural production has caused great distress and famine on the society in the past three or four decades. Therefore, from the 1980s onwards, it was strongly believed that rain fed agriculture should be supplemented by irrigation in order to achieve national food self-sufficiency and ensure household food security.

Concerning the country's irrigation potential, there are various estimates by different Organizations. FAO estimate put it at about 1.8 million hectares, while IFAD estimates 2.8million hectares (as cited in Gideon, 1990). The Ethiopian valley development studies authority estimates about 2.7 million hectare by adding up the irrigation potential of the country's major river basins and the rift valley lakes basin as shown in Table 2.1 below.

Table2.1 Main irrigable regions in Ethiopia

Regions	Gross Irrigable Area in Hectare
Blue Nile River Basin	760,000
BaroAkobo River Basin	600,000
WabiShebelle River Basin	355,000
GenaleDawa River Basin	300,000
Omo Gibe River Basin	248,000
Northern River Basin	200,000
Awash River Basin	203,000
Rift Valley Lakes Basin	47,000
Total	2,713,000

Source: Ethiopian Valley Development Study Authority, 1989.

According to the MOA report of 1993, the total coverage of irrigation in the country then was only 168,000 hectares which is less than 6 percent of the country's average estimated potential of 2.7 million hectares (as cited in Fuad, 2001). Moreover, it has also been indicated by Dessalegn (1999: 10-11) that in Ethiopia irrigations covers less than two percent of the, countries cropped land and if all the irrigated land is utilized to produce food crops the contribution of irrigation to the production of food can't exceed two per cent. This shows that in respect of the country's endowment with potentially huge irrigable land, irrigation has made little contribution toward agricultural development and national food self-sufficiency in Ethiopia.

Apparently, irrigated agriculture is not an entirely new phenomenon in Ethiopia. As indicated on some literatures, informal traditional irrigation culture has a history of more than one century in some parts of Ethiopia. Small-scale traditional irrigation has been practiced for decades throughout the highlands where small farmers could be diverted seasonally for limited dry season cropping (FAO, 1994). However, irrigation development in its modern sense has recently been introduced only comparatively in the country. It was during the time of Emperor Hailesilasse that modern irrigation development was introduced to Ethiopia mainly commercial large-scale schemes inthe Awash valley. Since the beginning of the1950s, some 6500 hectares of land have been irrigated with sugar cane, cotton and some cereal crops(IFAD, 1985).Following

the revolution in 1974, all large-scale commercial irrigation schemes were nationalized with the Ethiopian Sugar Corporation taking over the cane plantations and the Ministry of State Farm Development assuming responsibility for the schemes producing mainly cotton. At the early time of the *Derg*, like of the past regime, emphasis was given to large-scale irrigation development as part of the modernization and socialization of the country's agricultural economy (Dessalegn, 1999).However, the drought of 1984/85 produced a strong impetus towards irrigation with the government initiating programmers for the development of small and medium scale irrigation projects with the expectation that such schemes will provide a standard against the variability of rainfall. Accordingly, the ten years perspective plan (1984/85 - 1993/94) envisaged the development of 113,000 hectares and 13,000 hectares of large-scale and medium scale irrigation schemes respectively. During the early years of the plan period, some minor river diversion projects were undertaken in different parts of the country to assist drought victims and to reduce the adverse effect of recurrent drought. However, it has been reported that many of such projects were not sustainable due to lack of continual support in management and maintenance of infrastructure.

In Ethiopia, irrigation schemes are classified as small (up to 200 hectares), medium (200 to3000 hectares) and large (3000 hectares and above). There is also an intention that small schemes should focus on individual farms producing subsistence food crops, that medium scale schemes produce a mixture of subsistence food and cash crops; and that large-scale schemes could concentrate on cash crops. However, size may not always be a determining factor in the development of irrigation. Small-scale irrigation farmers could participate in the growing of cash crops if there is a ready market outlet for their production. Based on this

Understanding, EVDSA (1996) categorized irrigation schemes in to peasant/smallholders unit and commercial unit considering mainly the farm management practices or the principal objective of the farm.

At present, small-scale irrigation schemes in Ethiopia take two forms. The first form is the traditional scheme, which are organized and managed by the community members themselves. The other form is recently upgraded (with permanent diversion weir and lined canals) which government and some NGOs have constructed since the 1980s. According to the 1988 inventory

by MOA, there are 1309 traditional small-scale irrigation schemes covering about 60,000 hectares that scattered throughout the country (as cited in Gezmu1990). Such traditional schemes in most cases serve mainly to supplement and provide greater degree of security to peasant farmers' rain fed agriculture.

When we look at the performance level of irrigation in Ethiopia, small-scale schemes (especially those operated privately and traditional irrigation systems) have had a better record of success than large-scale schemes. This was attributed to the distinct characteristics many of such projects were not sustainable due to lack of continual support in management and maintenance of infrastructure.

2.7 Irrigation Development as a Strategy of Ensuring Food Security in Ethiopia

At national level, the major features of food security in Ethiopia are a persistent deficit in aggregate food supply, due to a steadily declining cereal production on a per capita basis. Contrary to this, the total population which has grown from 15 million in 1951 to about 80 million today worsens the food security situation of the country through time. As a result, an estimated 52 per cent of the country's population is food insecure or below the poverty line (FDRE, 1996).

Ethiopia has huge water resources potential that could be utilized for hydropower and irrigation agriculture. Though its impact is minimal, Ethiopian government has made efforts with the utilization of available water resources. Since the 1950s large-scale irrigation schemes with mechanization of agricultural activities especially in the Awash Valley were undertaken for the production of industrial crops like sugar cane and cotton. In the 1980s, the importance of small-scale irrigation systems was identified as a response of recurrent drought.

Currently, the sector's development appears to be moving in the right direction and due policy consideration is given. The federal government has established Water Resources Development Policy through its Ministry of Water Resources (MoWR, 1993). The policy has envisaged irrigation development as an integral part of the water sector to enhance food self-sufficiency and ensure food security at the household level and to develop an agricultural based industrial development in the long run.

In line with the broad ADLI strategy, the government adopted National Food Security Strategy in 1996 in order to achieve sustainable food security. The Food Security Strategy has been designed to coordinate and promote different programs and focuses on increasing food and agricultural production, improving food entitlement and strengthening capacities to manage food crisis.

To increase food production, the strategy focuses on diffusion of improved agricultural technologies within smallholder agriculture in areas where there is ample rainfall. On the other hand, the strategy has envisaged implementation of cost-effective irrigation schemes in drought prone and densely populated areas in order to reduce the vulnerability of the sector to the vagaries of weather and to address food insecurity problem at the household level. To this effect, it has indicated that priority will be given to smallholders' schemes (up to 200hectares) with indicative cost up to US $1,500 per hectare (FDRE, 1996).

From the point of view of attaining national food self-sufficiency and ensuring household food security, irrigation development would have the following objectives (FDRE 1996: 18)

- Improved food security in drought prone areas.
- Production of high value crops, especially fruits and vegetables.
- Production of crops for exports (possibly fruits and vegetables) or import substitution (especially sugar and cotton).
- Opening up new agricultural land in marginal climatic areas.

Generally, the above objectives have been realized through the accomplishment of small, medium and large-scale irrigation schemes both in the highlands and lowland areas where water resources are available for irrigation farming.

On other undertaking, the Ethiopian Interim Poverty Reduction Strategy Paper (2000/01-2002/03) emphasized the need for agricultural growth in general and irrigation developments the sub-part of the sector in order to reduce the level of poverty and improve food security situation of the country. Thus, in the strategy paper, it has been stated that irrigation would have to be introduced in a significant way for a sustainable attainment of food security at the national level.

The recent national focus on water resource development is the continuation of what had been done in the past decades. Since 1991, following the new administrative structure, National Regional States have taken the responsibilities of small holders' irrigation development. For instance, in the Amhara National Regional State, Commission for Sustainable Agriculture and Environmental Rehabilitation (Co-SAERAR) has been established for study, design and construction of small and medium scale irrigation schemes and micro dams. On the other hand, the management and operation of irrigation schemes is undertaken by Bureau of Agriculture and beneficiary farmers.

Based on this institutional setting, Co-SAERAR has constructed some irrigation schemes, particularly in the drought prone eastern parts of Amhara region.

2.8 Assessment of Household Food Security

Food security is frequently defined as access by all people at all time to the food they need for an active and healthy life (World Bank 1986). Household food security in turn means adequate access by the households to amount of food at the right quality to satisfy the dietary needs of all its members throughout the year.

A number of interrelated factors determine food security situation, which are related to the process of food acquisition, household procurement strategies and socio-economic conditions of the society. The basic resources like land, asset owned (productive and disposable),market, income sources, labor and humanitarian assistance are key factors for either promoting food security or increasing vulnerability to food insecurity. Therefore, the access of households to food is indicated by the amount of its production, type and volume of assets it owns, the amount of farm and off-farm income it has been able to earn and its access to community support mechanism.

Assessment of food security is a difficult issue, mainly because of the availability of a wide range of alternative indicators of the level of food security at the household and community level. Thus, what is needed now is a refinement of the methodology for selecting and weighing of indicators of household and regional distress and customizing the available indicators for use in a location-and context-specific manner (Webb and Von Braun 1994).

In this particular study, the attention is to examine the role of small-scale irrigation to assure household food security in a drought prone locality of north Wollo Zone. Irrigation is one of the basic agricultural inputs for intensification and diversification of agricultural activities and to increase agricultural production. In this context, it is assumed that the high yields Obtained in irrigation coupled with other benefits such as increased incomes and asset owned will assure food security at household level. Therefore, the measuring variables of household food security in this study should be largely related with the issues of agricultural production, household asset and income sources.

For the case under consideration practical, the following socio-economic variables/indicators in Combinations are used to assess the household food security situations of irrigator's there by appreciating the role of irrigation in addressing food insecurity problems.

- ✓ *Agricultural production:*Amount of production with regard to *Meher*and *Belg*(Irrigation) harvest and agricultural productivity per unit of land.
- ✓ *Agricultural inputs used****:*** **-** Chemical fertilizer, improved cereal seeds, vegetable and fruit seeds.
- ✓ *Household Assets:*Productive Assets-land, draught oxen and other household assets.
- ✓ *Household Income:*Income from cereals, cash crops, sells of livestock's, etc. Off farm incomes (labor wage, petty trade, etc.)
- ✓ *Humanitarian Assistance:*Type and amount of food aid received (Duration of Assistance).
- ✓ *Household composition:*The ratio of productive versus non-productive household members.

Any kind of undesirable conditions (low level, not available or bad condition) in the abovementioned measuring variables might indicate a deteriorated situation of food security status of the households concerned. However, it could be understood that any one variable alone could not show the reality in the given household. Moreover, in order to see the impact of irrigation more clearly, a comparative analysis of households based on the above variables is under taken between irrigators and other households who are totally dependent on rain fed fields.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

Lalibela woreda is one of 166 woredas of the Amhara National Regional State and one of the 9woredas of North Wollo Administrative Zone. The woreda is situated in the Tekeze watershed 700 k.m away from the capital city of Ethiopia. 300 km away from Bahir Dar,(the capital city of Amhara region) and 180k.m way from woldya the town of north Wolloadministration.Geographically the boundary of the woreda is neighbored by in north Tigray, in south Mekete woreda, in east Wage-Himira, in west Ayna-bugna woreda.

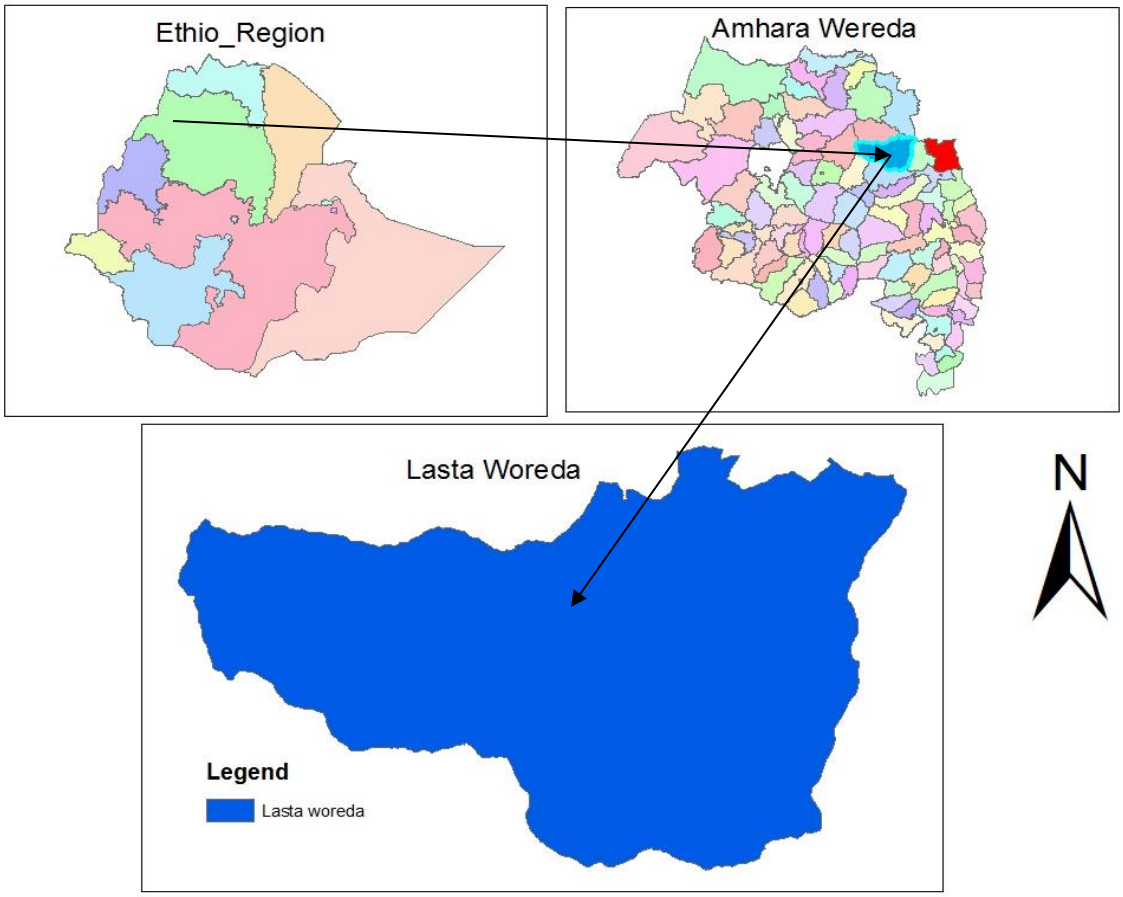

Figure3. 1 Location of sample irrigation schemes map

3.1.1 Agro-ecological zones

The Lalibela woreda is geographically located between 23^0N latitudes and 66^0 E longitudes and has an estimated area of 113,874.24 hectares. The woreda has four agro-climatic zones comprising 36% kola, 48.1% W/dega, 15.4% degaand 0.2% frost, the averageelevation of the woreda ranges from 1600-4200 meters above sea level and the mean annul average temperature is about 15 degree centigrade .

3.1.2 Population

The woreda has a total of 23 kebeles and the total population of the woreda is estimated to be119, 482 out of which 60,038 are male and 59,444 are female. The livelihood of thispopulation is based on mixed farming based on these the average land holding is 0.5-0.65hectaresExcluding the 2446 unemployed youth (L W A O, 2012 report) and the livestock populationis cattle 47,994, sheep 76,937, goat's 83,675 horses 338, and donkey 10,821 mules1116poultry 836 .

3.1.3 Nature of Rural Settlement

People in rural areas belong to Kebeles that ranges from 4,500 to 5,500 persons. The Kebeleor peasant associations as they were commonly known were established in the mid seventiesfor the purpose of executing the land reform programmed by the *Derg*regime. They stillcomprise the lowest level of the administrative structure of the woreda but haveacquired responsibilities in the areas of law enforcement, distribution of relief food and socioeconomicdevelopment. The Kebeles are divided in smaller units, *Gotts*, which consist of anumber of families under the leadership of development team. The settlement pattern in the woreda is highly scattered. People live in hamlets, small groups' ofdwellings that contain an extended family as near as possible to the land they cultivate.

3.1.4 Land Use Pattern

The available data with regards to land use in the woreda vary considerably; however based upon the data from the Department of Agriculture of the woreda, nearly half of the land is nonutilizablefor agricultural purpose. Most of the land is mountainous and characterized bysteep slopes, unsuitable for agricultural purpose thus; the cultivated land is limited to 58 percent of the total area.

Table: 3. 1estimated land use pattern within Lalibela woreda

Land Type	Area (ha)	% Share
Cultivated Land	66,694.94	58.56
Currently non utilized	4,253.17	3.7
Forest Land	21,491.16	18.87
Bushes and Shrubs	1200	1.11
Grazing Land	5,305.26	4.65
Other types of land(mountain)	14,929.71	13.11
Total	113,874.24	100

*Source:*Lalibela Woreda Agriculture office, 2015

As can be seen from Table 3.2, only 3.7 per cent of the total land is estimated to be availablefor further expansion for agricultural activities. This has the direct implication that intensifiedmethods of production are the sole means of increasing crop production in the woreda. Thenature of the land coupled with that of population pressure has resulted in individualhouseholds farming very small areas.

3.1.5 Major CropsCultivated in the Woreda

With regards to crop production, the woreda is dependent on both the *Belg*and*Meher*seasons. According to the available data from the office of Agriculture, themajor crops cultivated during the short rain (*Belg)* season, in order of importance are Barely,*Teff*and Lentils, while during the main rain (*Meher)* season the most important cultivatedcrops are Sorghum, *Teff*, Maize, Wheat, Barely, Chick peas, Faba beans and lentils.

The Woreda also benefited from irrigated crop production, although thetotal area is small as compared with the rain fed fields. Maize, Sugarcane and *Teff*cover thelargest portion of cultivated land under irrigation.

3.2 Description of Sample Irrigation Schemes

Two irrigation schemes in Lalibela Woreda were chosen for the purposes of this study, and it is appropriate to discuss some of their basic characteristics in this section. The sample irrigation has some common characteristics. The agro-climatic ecology of the two sample irrigation is similar in some part. In each sample, the *belg*and *meher*are two cropping seasons. The *belg* cropping season is a very short rainy period whereas *meher* season is the long rainy period. Farmers depend on *meher* season for rain fed crop production. The onset, duration and quantity of the rainfall are variable. Agriculture is the major occupation of the people in the Woreda. The agriculture in all households is a mixed crop–livestock farming system. Crop production is rain fed during the rainy season, supplemented for some households by small-scale irrigation in the dry season. The dominant crops grown in the study area are*teff,* wheat, barley, maize, beans, peas, chickpeas and lentils. Commonly produced vegetables are onion, tomato, potato, pepper and cabbage.

3.2.1 Belebala Area Traditional Irrigation Schemes

Belebala is a locality in North Wollo Zone and is found in Lalibela*Woreda*, 32 km north ofLalibela town (Woreda). It has a mid-altitude (*WoinaDega*) agro climatic zonewith moderate temperature but highly variable rainfall.

Traditional river diversion is the dominant method used by farmers in the kebela. This irrigation system is simple for farmers to practice by inheriting the knowledge from grandparents but the amount of water and seasonality of rivers are major problems.

Around Belebala, one finds a number of perennial springs and streams which coming up from the nearby mountain are sustainable source of water for irrigation. The method of irrigationpracticed by farmers is the use of simple technologies of temporary diversion structures andearth canals. Long time experience has taught farmers how to construct and maintaindiversion structures and earth canals on river beds, along steep hillsides and on farmfields. They also use hollow wood or iron sheet to make gully crossing flumes.

One major problem of irrigation practice in Belebala is that such temporary and unstablestructures are often destroyed by the water flow during the main rain season. As a watercommittee member in one of the schemes reported, an average of 200people per day have worked for about 10 to 15 days each year in October to construct a stonebund that lift up water from the water course of *ThemeketeBahere* river.

Traditional irrigation systems in Belebala area are the most successfully performed schemes inNorth Wollo. It has totally initiated and undertaken by the community themselves, withoutexternal assistance in any form. Irrigation in Belebala area has been a long tradition andaccording to the information from some respondents, it dates back more than one century.

In the past times, irrigation was mainly practiced for some perennial crops like citrus, banana and vegetables such as onion and garlic. But from 1970s onwards as a result of theircurrent drought, irrigable area has been expanded and intensification and diversification ofagricultural practices have increased. At present, there are about 17 blocks of schemes with an estimated irrigable area of 112 hectare, which benefited about 560 households of the area (Table 3.6).

Table: 3. 2 Traditional irrigation schemes in Belebala area

Kebeles	Water Sources	Irrigation Area (ha)	Beneficiary HHs	Average Plot Size Per HH (ha)
	Gedebugedamayet	10	34	0.209302
	Mesenomeneder	9	43	0.181818
	Gedamayetweneze	6	33	0.166667
	Agotabaher	5	30	0.171429
	Jegoreye	6	35	0.114286
Belebala	Gedebuarecheko	4	35	0.129032
	Sawole	4	31	0.076923
	Shemamathebeya 1	2	26	0.333333
	Shemamathebeya 2	9	27	0.108108
	Shemamathebeya 3	4	37	0.351351
	Yeketemawu	13	37	0.153846
	Deledeyu	4	26	0.21875
	Deleboye 1	7	32	0.071429
	Deleboye 2	2	28	0.2
	Arecheko 1	7	35	0.292683
	Arecheko 2	12	41	0.2
	Cherkose	8	30	0.209302
	Total	112	560	0.2

Source: Lalibela Woreda Agriculture Office, 2015.

As can be seen from the table 3.6, all possible irrigable land and water resources are beingused for irrigation. However, small plot size per household is a critical problem of irrigators.This is mainly due to high population pressure in the area. For instance, one of the *Kebeles(*Belebala) alone has a total of 10,200 inhabitants, where as the *Woreda* average populationper *Kebele*is found to be between 4500-5500 people.

Management and Operation of the Schemes

Since irrigation has been practiced for at least a century, farmers have good experience ofwatercourse operation and maintenance. There is also high degree of social cohesion withinthe farming community regarding the tasks of irrigation infrastructures. Farmers are oftenwilling to accept any order from their elected water committees and undertake constructionand maintenance activities. Elected water committees (*WuhaAday*) have undertaken themanagement and operation of each block of scheme. There are only three members of thecommittee whose main functions is water distribution, coordinate members for any activitiesof the schemes and conflict resolution among irrigators.

3.2.2 Tekeza Modern Irrigation Scheme

Tekeza irrigation scheme is located in North Wollo Zone, Lalibela Woreda, and ShalloKebele about 13 km north of Lalibela town along with Lalibela to Woldya highway. In the project area traditional irrigation had been practiced since manyyears ago, though the scale of operation was very small.

River diversion irrigation systems are practiced in the Shallokebela and Tekeza River is the main source of water for the modern irrigationsystem in Shallokebela.

The idea of formal irrigation development was initiated in the late 1980s by IrrigationDevelopment Department of the then Ministry of Agriculture, North eastern Regional Office.The project was planned as a long-term solution for the recurrent drought in Wollo that wasaggravated again in the mid 1980s. It was planned to improve traditional irrigation systemand to increase irrigation areas through construction of permanent structures. However,except some preliminary study and minor activities to support the then cooperativeproducers', major development activities were not undertaken until 1991.

It was in 1993, after the establishment of the Amhara National Regional State that Tekezairrigation project was considered again. After the completion of feasibility study and designof physical structures, diversion weir construction was started in 2000 by ORDA. The

weirsite has been located at the neck of the river course where elevation from which a maximumof land could be commanded to supply irrigation water through gravity.

Tekezairrigation scheme started operation at a full scale in 2012. At present the totalirrigable area of the scheme is 178 hectares. There are about 1439 beneficiary households(1189 male and 350 female headed) with an average plots size of 0.12 hectare (1500m^2) thatranges between 0.04 hectare and 0.5 hectare per households. According to informationobtained from respondents, such a skewed plot size per household is due to unfair landdistribution held in 1989.

The main structures constructed include headwork, 6km main canal and 6km long ofsecondary canal. Other field structures or tertiary canals are earth ditch constructed byfarmers. The permanent structures are used to increase the volume and speed of water flow,reduce seepage losses and increase the area of land under irrigation.

Management and Operation of the Scheme

Based on the institutional framework of irrigation developmentin the region, the management and operation of the scheme isthe joint responsibility of the Bureau of Agriculture andbeneficiary farmers. From the side of agricultural office, aresident irrigation extension worker has been assigned to offer assistance to farmers in terms of water management and some agronomy practices. From beneficiary farmers' side, irrigationwater committee has been formed since 2012. Watercommittee is a group of farmers elected by the beneficiariesbased on their ability and respect to the community.

In addition to the main water committees, farmers are grouped in to 6 blocks and 46 unitseach having 20-30 farmers. Water distribution schedule is set to each block and unit's basedon their spatial order of plots and time of turn. Each block has its own leader and reportdirectly to the main water committee.

Table: 3. 3 Organizational structure of water management in Tekeza scheme

Block	Number of Units	Number of Farmers	Area of Land (hectare)
Canal 1	8	241	10
Canal 2	12	361	72
Canal 3	6	200	24
Canal 4	8	251	42
Canal 5	8	241	16
Canal 6	4	145	14
Total	46	1439	178

Source: Record note book of extension worker, 2015.

The major functions of the water committee are:

- Water distribution to members based on commonly agreed schedule
- Maintenance and cleaning of canals and guarding structures against damage and thefts.
- Settle any sort of disputes among members and penalize non-conforming members based on the group by-laws.
- Assist extension workers on coordination, input distribution, etc.

Water committee in Tekeza scheme has own by-laws, which is prepared in collaboration with the Woreda Agricultural Office. It was indicated that any conflict arising from the use of water is settled through the committee although there are some cases that are referred to Kebelecourts. However, some informants said that the water committee is not efficient enough to coordinate members and enforce group by-laws. This is mainly due to the fact that committee members have no incentives and they are often reluctant to take action on those who do not abided by group by-laws, in order not to quarrel with their colleagues and neighbors.

3.3 Methodology

3.3.1 Methods of Data Collection and Analysis

3.3.1.1 Selection of Sample Irrigation Schemes

Among the nine Woredasof North Wollo Zone, LalibelaWoredahas better surface water potential for irrigation development. Most of the areas of the Woredascomprise the lower plain of the eastern escarpment of North Wollo highlands and part of the fertile land of Tekeze valley. The perennial streams that flow from the highlands could be a potential source of irrigation water to the vast irrigable plain during the dry season and when the amount and distribution of the main rain is found to be inadequate for plant growth. Currently, modern (formal) irrigation development in north Wollo Zone is concentrated on river diversion projects located in the three Woredas. For the purpose of this study, two irrigation schemes were purposely selected from LalibelaWoreda ofNorth Wollo Zone. These are Belebalaarea traditional irrigation schemes and Tekeza (formal)irrigation scheme. According to the information collected from some informants, the traditional irrigation system around Belebala dates back to at least one century and the scheme have successfully performed. On the other hand, Amhara Regional State, mainly in response to the recurrent drought in the area constructed Tekeza irrigation schemes in the 2000s. Therefore, the selection of study schemes was made based on type of schemes (traditional and formal), performance level and location accessibility of irrigation schemes. Moreover, to compare irrigation households with their non-irrigation counterparts, an equal sample size of non-irrigation households were drawn from the same *Kebele*where irrigation schemes are found. Thus, the difference between sample irrigators and non-irrigation households is limited only to access to irrigation water.

3.3.1.2 Sampling Method

As it has been indicated in the above section, sample population was classified into two groups' irrigators and non-irrigation households. Sample households from each irrigation schemes and kebeles were identified using systematic random sampling technique from the Kebele list of households. The overall sample size was 120 households, 60 from irrigation and 60 households from non-irrigation group. The sampling population was drawn from a total of 1999 households

in irrigation group and 1647 households from non-irrigation group from the two sample irrigation schemes and non-irrigation households within the respective schemes and kebeles. In Tekeze scheme of Shallo*Kebele*out of the total 1439,410 irrigation HHs and 30 non-irrigation HHs each were selected randomly. In Belebala scheme of Belebala*Kebele*, out of the total 560 irrigation and 1257 non-irrigation HHs, 30 HHs from each group were drawn using systematic random sampling technique respectively. Therefore, the sample size is believed to be representative and can generate reliable information since each group of households going to be homogeneous in their socioeconomic settings.

3.3.1.3 Methods of Data Collection

For this study both quantitative and qualitative data from primary and secondary sources have been gathered and analyze. Thus, the following data collection methods in combination were employed during the data collection process of this study:

3.3.1.3.1 Household sample survey

In this study, the conventional household survey was the main method used to collect quantitative information. A carefully designed questionnaire consisting of interrelated questions was employed and administered by semi-trained enumerators. Sample household heads were the unit of analysis from whom quantitative information was collected. The fieldwork was completed over a three-week period from august 1 to 22 September 2015. Two enumerators were employed to conduct the survey under the close supervision of the researcher. The enumerators were development agents in each irrigation schemes and kebele. Prior to the launching of the survey, enumerators were briefed about the survey and familiarized with the questionnaire. Development agents were chosen as enumerators due to their knowledge and acceptance among the community that helped the researcher get the questionnaire filled properly.

3.3.1.3.2 Qualitative Data Collection Methods

The qualitative assessment added useful in depth and perspectives in understanding issues that could not be obtained from questionnaire method. Qualitative data collection methods are used to obtain insights, thoughts and attitudes of peasants concerning irrigation development in the study

area. In a more practical sense, information gathered using these methods include management and operation processes of the schemes, past experiences and role of the community in irrigation development, the role of irrigation in preventing the adverse effect of drought in the past decades, problems and constraints of irrigation development, etc.

3.3.1.3.3 Focus Group Discussion

Focus group discussion with peasants was one of qualitative data collection method in this study. Each focus group comprised within the range of 5 to 8 individuals who are found in the same village in the study area.

3.3.1.3.4 Key Informant Interview

Individuals who were considered popular and rich in experiences about irrigation activities and socio-economic condition of the community in the study area were identified and interviewed individually. The key informant's interviewed were including elderly people, local religious leaders, water committee members, development agents, Woredaand Kebeleofficials and zonal experts. In addition to the formal interview, the researcher also benefited from the informal discussion with experts and colleagues at Woredaand zonal level. Moreover, field observation helped the researcher to better understand the over-all process of irrigation development and cross check data gathered through household survey and key informant interview.

3.3.1.3.5 Secondary Data

In addition to primary data, secondary data were also used in this study. Secondary data from unpublished records and reports were obtained mainly from the following institutions; North Wollo Department of Agriculture, Lalibela Woreda Agriculture Office, Lalibela Woreda water Office, Department of Planning and Economic Development and NGOs Working in the Woreda. Literatures related to irrigation development and food security issues from libraries and other institutions have also been reviewed.

3.4 Methods of Data Analysis and Presentation

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. Quantitative data analyses were carried out using simple and relevant statistical methods such as average, percentage and frequency distribution and T-test for Means. In order to see the socio-economic impact of irrigation schemes, comparative analyses were made between irrigation and non-irrigation households.

4. RESULT AND DISCUSSIONS

This section describes the analysis of survey data and its interpretation. In the first section, the sample households' demographic characteristics are discussed. Particular reference is given to the factors hypothesized to influence income, such as family size, land holding, asset holding and labor availability for irrigating and non-irrigating households. These descriptive analyses help to frame the econometric results obtained in the study.

Agricultural production requires resources such as labor, natural resources, agricultural tools and other capital assets. In the foregoing sections, it has been discussed that household income has a critical link with access to productive resources such as labor, land, oxen and agricultural assets. Therefore, the study looks the access of these resources between irrigating and non-irrigating households. Knowing this helps to judge irrigations impact on households income difference.

4.1 Family size and Labor Availability

Family size is useful for formulating various development plans and for monitoring and evaluating their implementation. Average family size at the national level in Ethiopia was 4.7 (CSA 2007). In the study area,the average family size in the sample population is 4.9 people per household. Out of 587sample population, about 32.7 %are children below 15 years old. The economicallyactive population that is found within the age group of 16-64 is found to be 49.7 % of thetotal population.

The number of family size has a strong relation with other household resource endowments. For example, the family size has direct relation to land holding size and income of the family,though this is not always true in all cases. Family labor in traditional agriculture is the mostimportant factor of production both for increasing income and production and hence foodsecurity. According to the result of the sample survey, a family with an average size of 4.9people has a labor force of 3.3 people, which are about 62.5%of the total familymembers (including children with the age group of 10-14). In rural economy, children laboris mostly used for cattle rearing and in some areas children with in the same age groupparticipate in agricultural activities, especially in weeding and threshing.

Table4.1Demographic Characteristics of sample households

Description	Household Category		Total
	Irrigation	Non-irrigation	
Total population by age	297	290	587
≤10	93	99	192
10-15	40	35	75
16-64	147	145	292
≥65	17	11	28
Average family size	4.9	4.8	4.9
% of potential labor force	62.6%	62.1%	62.5%

Source: Household Survey Result, September 2015.

As shown in the table above, there is no wide variation in the family size and laboravailability between irrigation and non-Irrigation households. Compared to small averagefarmland, a household owned (about half a hectare); shortage of labor should not be a seriousproblem at a household level. However, since irrigation is a labor-intensive agriculturalpractice, labor demand for irrigation households is expected to be higher than that of rain fedhouseholds. Accordingly, about 22 (36.7%) of sample irrigation households havereported that they use hired labor during the peak season of field preparation and planting ofirrigation land.

The labor force has also a strong relation with the household level of off-farm income andagricultural productivity. The survey result revealed that most of the households who haveparticipated on daily labor, petty trade and out migration have a family size of 4 and above.

This implies that as family labor supply increases, the more the household are food secured asthey have opportunities to participate both in agriculture and off-farm activities. However, such situation is highly constrained with limited off-farm employment opportunities in thestudy area.

4.2 Land Distribution.

At national level, the major distribution of land was carried out in1975, following theoverthrown of the Imperial Government. It was done through a legislation issued by the *Dreg* government, which succeeded the Imperial regime. In North Wollo zone, as in other parts ofNorthern Ethiopia, the last distribution of land took place in 1989, three years before EPRDFassumed power at the national level in1991.

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

In Lalibela woreda, especially in the *Kollakebele*of Shallo, and *weyena-dega*kebela of Belebala, there has been a custom of dividing the land into two categories: *Wojed*land (land close to homesteads) and *Berha*land (land found far from homesteads). Family size and fertility of the land primarily determined the amount of both *Wojed*and *Berha*land received by each household.

Table4.2 Land distribution pattern at Belebalakebela, 1989

Land category	Family size		
	2	4	6
Fertile (*Wofram*)	17mX50m	19mX50m	21mX50m
Middle (*Mekakelgna*)	25mX50m	28mX50m	31mX50m
Infertile(*Sismeret*)	38mX50m	40mX50m	44m X50m

Source: Household Survey Result, September 2015

Again, it has been reported that the amount of land received by each household varied in eachagro-ecological zones i.e., mid-latitude (*Woinadega*) and low land (*Kola*) *kebeles*. This ismainly due to the availability of land and population density of the *kebeles*. Data in Table 4.2

shows the situation in *Woinadega*agro climatic zone of Belebalaarea, where there is an acuteland shortage and high population concentration.

Regarding the distribution of irrigation land in the study area, the method used varied at eachirrigation schemes. In Belebala area for example, irrigation land was considered as both *Wojed*and fertile land and the initial plot issued to husband and wife was 17mx50 m (850m^2 whichis about 0.085 hectare). Where as in Tekeza scheme, irrigation land was categorized as*Berha*and averagely fertile land that the amount allotted per household was larger than thatof Belebala area scheme. It was a third category of land (in terms of location) andpeople termed it as "*Berberemeret*", land used to grow green pepper. Therefore, irrigationland was distributed to a maximum possible number of households, which resulted in verysmall plot size per households.

Table4.3 Average landholdingsize of sample households by type in hectare

Kebeles(schemes)	Householdgroup	Sample	Average land Holding (ha)		Total
		Household	Irrigation land	Rain fed land	
Belebala area	Irrigation	30	0.2	-	0.2
	Non irrigation	30	-	0.510	0.510
Tekeza area	Irrigation	30	0.12	0.560	0.68
	Non irrigation	30	-	0.820	0.820

Source: Household Survey Result, July 2015.

* Survey data were reported in terms of "*Timad*" of land, the amount of land that can be ploughed within one day using a pair of oxen. Based on the available information, 4 *Timad*of land is equivalent to one hectare.

As shown in the Table 4.3 above, there is a significant difference in average land holding sizeper household in each *kebele*and irrigation scheme. This is mainly related to the availabilityof arable land and population density of the area. The larger land size in Tekeza areaisexplained by the fact that this *kebeke*is located in the *kola*agro- ecological zone where theland plots generally are larger than in the *Woinadega*zone.

4.3 Small-scale Irrigation and Food Crop Production.

Crop production is the major activity in the *Woreda* of Lalibela together with livestockproduction. The crops grown without irrigation (rain fed) in the study region are *teff*, barely, wheat, maize, oat, vetch, check pea, onion, tomato, potato and pepper. In addition to their rain fed cultivation, irrigating households produced cash crops for the second round within a year in dry periods using irrigation water. The first main crop season is from June to November. In this period both irrigating and non-irrigating households produced rain fed crops. The second crop season is practiced in dry seasons from December to April. In this cropping season, only irrigating households can cultivate using water from irrigation. 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. The most common field crops (cereals) produced by small-scale irrigation are maize, sorghum, wheat and barley whereas the most commonly produced irrigated vegetables are onion, tomato and potato (Table 4.4).

Table 4.4 Major food crops cultivated in the study area (2014-2015)

Kebele (Schemes)	Altitude Masl	Food grain cultivated	
		Main rain (Meher)	Irrigation
Belebala area	2200	*Teff*, maize, sorghum, Wheat, barely pulses.	*Teff*, maize, check pea
Shallo (Tekeza)	1800	Sorghum, *Teff*, maize, pulses.	*Teff*, maize, Sorghum, check pea

Source: Household Survey Result, September 2015.

As reported by the informants, production from the rain fed fields has not been sustainablemainly due to the unreliability and poor distribution of rainfall. Under such situation,irrigation households have produced two times in year sustainable using irrigation water in thedry season and through supplementary irrigation during the years of unsatisfactory wetseason.

When this survey was conducted in September 2015 for example, it was observed that any typeof crop cultivated in the area would be limited only in irrigation schemes. Through such intensive and sustainable production system, irrigation households would be able to meettheir consumption needs from their own produce better than their non-irrigation counterparts.Farmers and extension workers reported that the productivity of irrigation land is almostdouble 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 alimiting factor and there has been better farm management practice of irrigation farming. For instance, one of the beneficiaries in Tekeza scheme reported to have harvested 9 quintal ofmaize from one *Timad* (0.25 hectare) of land last year. He further indicated that if it was mainrain (*Meher)* harvest he could have got 4 to 5 quintal of maize from the same land.

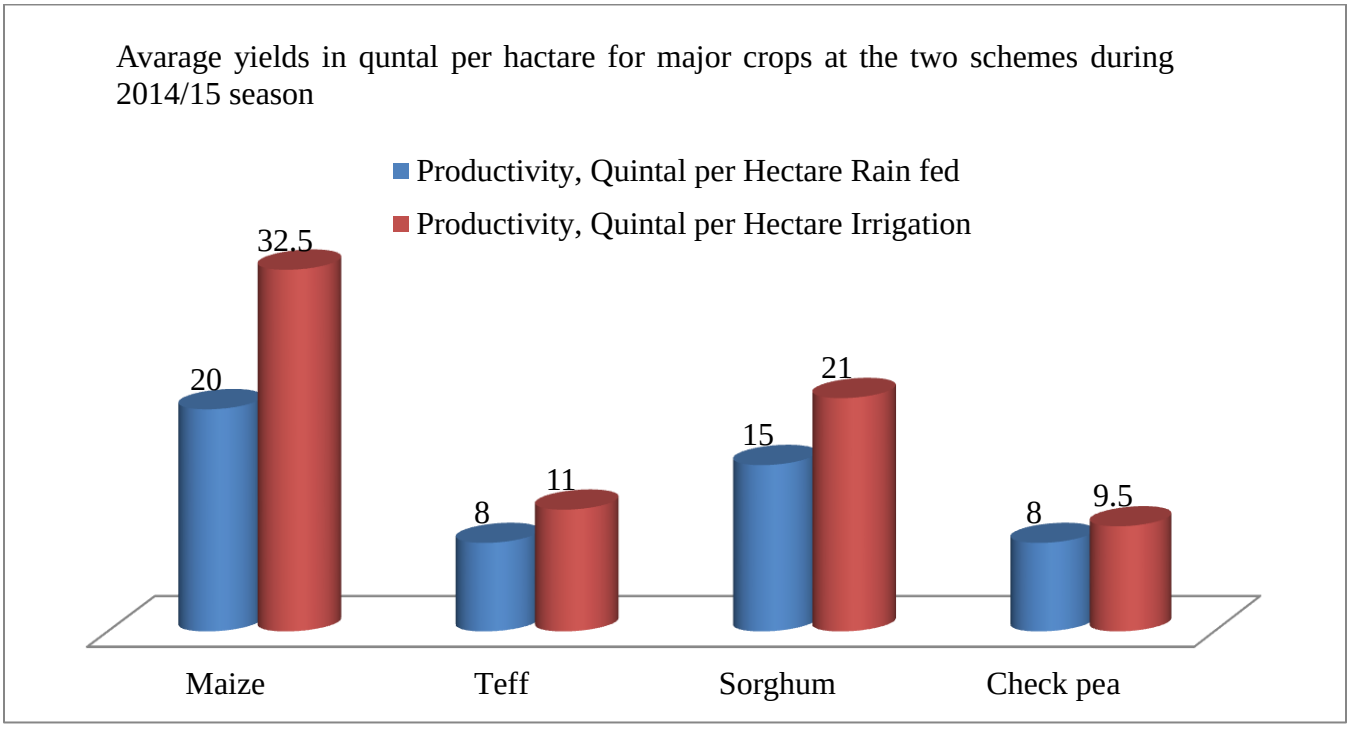

Figure 4.1 Average yields in quintal per hectare foe major crops at the two schemes during the 2014/15 season

Source: Household Survey Result, September 2015.

According to the survey results, 58.3 % of sample irrigation households have usedchemical fertilizers both for crop and vegetable cultivation, which enable them to get themaximum

possible amount of produce from a small plot of land. However, farmers in thetwo schemes have reported that they could not produce beyond their subsistence need fromirrigation due to small size of irrigation plots per household.

Now, let us examine the contribution of irrigation to household agricultural performance andthe level of household food self-sufficiency from their production. The result of thissurvey is summarized in the figure 4.2 below.

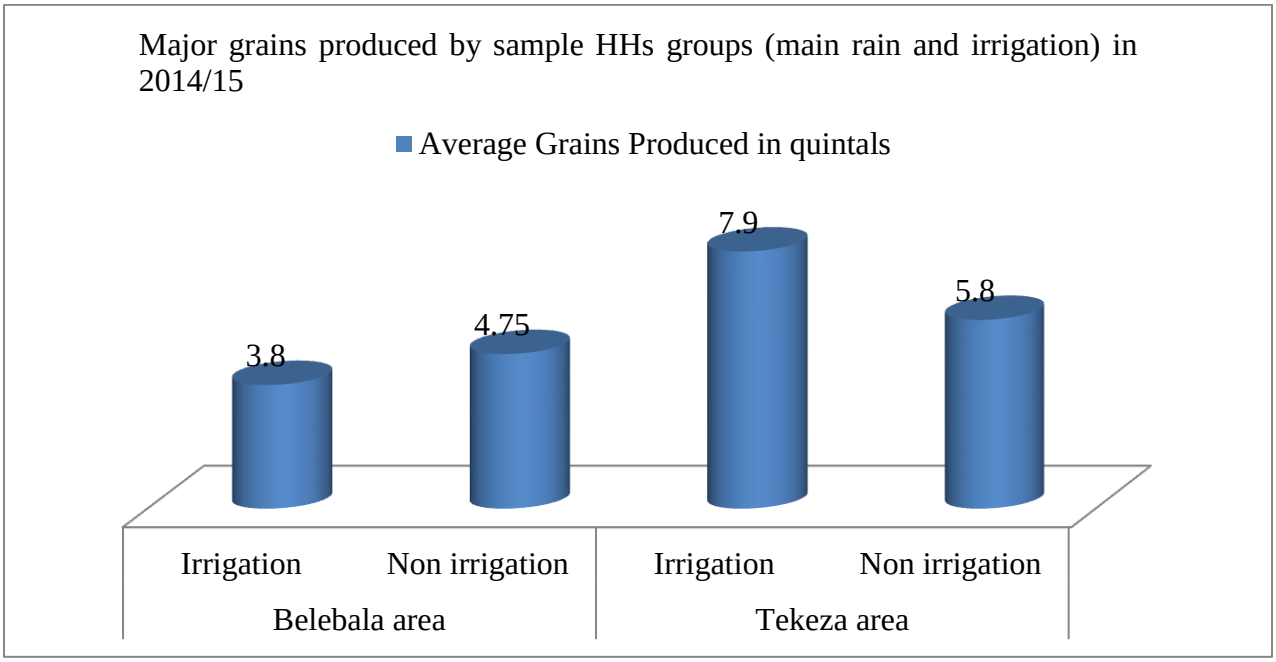

Figure 4.2 Major grains produced by sample household groups (main rain and irrigation) in 2014/15

Source: Household Survey Results, September 2015.

As can be seen from the above figure, in Belebalakebelenon-irrigation households have beenable to produce about 0.95 quintal more food grain as compared to irrigation households.There were two reasons for this. One of these was the difference in land holding size amongthe two groups and the other was most of the irrigation plots were covered with cash crops (mainly sugar cane) instead of food crops.

In Shallokebele (Tekeza) too, irrigation households have been able to produce about 2.1 quintal morecereals as compared to the rain fed households. Maize is the only major cereal grown in

thescheme. It has been reported by Lalibela Woreda Agriculture Office (2014/15) that,out of the total 178 hectare irrigation land of the scheme, 177 (99 per cent) hectares werecovered with maize in the 2014/2015*Belg* season. Extension workers of the scheme alsohave reported that 45 quintal of maize was produced per hectare in the same year frompioneer variety of maize.

Table: 4. 5 Comparisons of average yearly food grain produced by sample household groups in kg (2014/15)

Household Group	Mean Amount of Food Grain Produced in Kg			
	N.O of HHs	Mean	StDev	T-Value
Irrigation	60	616.7	306.11	2.735***
Non-Irrigation	60	466.7	294.68	

Source: Computed from figure 4.2, *** Shows Significance at 1% level

As shown in Table 4.5, the average amount of food grain produced by sample irrigation andnon-irrigation households is 616.7Kg and 466.7 Kg respectively. The table further shows thatthere is significant difference in the average food grain produced by the two groups ofhouseholds at 1-% level. The above comparison on food crop production of sample irrigationand non-irrigation households was made based on 2014/15 annual harvest. It was a year inwhich rainfall distribution during the main rain season was normal for crop production. If thecomparison were undertaken during the bad (drought) year, crop production of non-irrigationhouseholds would be less of the amount indicated in this survey.

In the above analysis, an attempt is made to show the role of irrigation to sustain and increaseagricultural production using average annual production of sample households. It will be more precise to see the effect of irrigation, if we examine the extent to which cerealproduction is sufficient for consumption requirement of each household. One of themethodologies used to identify household food security condition is to take food self-sufficiencyperiod of the household from what they produced as understood by the householdthemselves. This was obtained by direct interview of the household .The result of this surveyis presented in Table 4.6 below.

Table 4.6 Households consumption sustainability from their own production, 2014/15

Food self- sufficiency months	Household Group			
	Irrigation		Non-Irrigation	
	HHs	%	HHs	%
< 3	2	3.31	9	15
4 to 6	21	35	29	48.3
7 to 9	14	23.33	11	18.3
10 to 11	11	18.3	4	6.6
12	12	20	7	11.6
Total	60	100	60	100

Source: Household Survey Result, September 2015.

Based on the survey result, it is only 20 % and 11.6 % of sample irrigation andnon-irrigation households could feed themselves adequately throughout the year (irrespectiveof the nutritional status of their food intake). As indicated in the above table, about 38.3% and 63.3 % of irrigation and non-irrigation sample households have reported thatthey could feed themselves only up to six months of the year from their own food cropproduction. However, since irrigation brings extra income from the sale of cash crops,irrigation households could purchase some of their food needs and could be more foodsecured than the non-irrigation households.

The major role of irrigation to household food security in the study area is, therefore, throughsustaining and increasing of agricultural production. According to the informants in the twoschemes, irrigation harvest is valued ten times more than the main rain harvest because of itsimportance in saving lives during the drought situation. Moreover, irrigation harvest reaches at a very critical period of June, when the food stock from main rain production is exhaustedand the price of food grain is very high at the market. Therefore, irrigation harvest is mainlyused to cover the food requirement of the family during the main rain season (July-September) which is often known as a time of periodic hunger in Ethiopian high lands.

4.4Irrigation and Agricultural Input Use

The scope of increasing the area under crop in the study area is almost non-existent becauseof high population pressure. Most of the areas, which are suitable for crop production, havealready been used. More importantly, cultivation has long been expanded in to the marginalsteep hillsides. It has been believed, therefore, that increasing the use of fertilizer remains thesole means of maintaining soil fertility as well as increasing agricultural production.

The use of modern agricultural inputs (fertilizer and improved seeds) has been introduced tothe study area since 1995 through the new agricultural extension program of the government.It is known that agricultural package works only when reliable rainfall provides sufficientmoisture. However, the adoption of the new agricultural technologies has been constrained by moisture stress problem and high price of inputs. According to information obtained from the*Woreda* agricultural office, the annual amount of fertilizer used in the *Woreda* is about 800quintals (both DAP and Urea) from which 75 % has been utilized in irrigation schemes.

It is known that irrigation is not a stand-alone technology. Although it helps to increaseagricultural production, high return depends on other factors such as adequate usage offertilizer and labor. Irrigation promotes the use of other inputs through supply of moisture attime of unreliable rainfall. Accordingly, the survey result revealed that 35 (58.3 %) and 8(13.3%) of sample irrigation and non-irrigation households used fertilizer during 2014/15cropping year respectively. This was due to the fact that the productivity of vegetables thatare grown under irrigation relies heavily on fertilizer. Moreover, income from cash crops andincreased production enables irrigation farmers to afford the high price of inputs.

4.5Cash Crops Production and Marketing

Cash crops in this context refer to crops produced through irrigationdecidedly for the sole purpose of sale in order to generate household cash income. This doesnot indicate that other crops are never sold. In the study area it has been found that mosthouseholds have sold *Teff*to purchase cheaper crops such as maize and sorghum butcultivation of *Teff*cannot be described as a cash crop. One of the major advantages of irrigation is the possibility of adopting high value

crops(vegetable and fruits) which need year round water supply and are reliable source ofhousehold income.

According to the available information, cash crops grown in the schemes include vegetables(onion, potato, garlic, sugar cane, tomato, pepper, cabbage, etc) and perennial crops (citrusfruits, coffee, banana, papaya, etc). The amount of cash crops cultivated in each schemedepend on farmers experience on management and technical skills to grow such crops,market situation, seed availability and farmers preference to grow either cash crop or cereals.It has also been identified that irrigation extension service to provide technical assistance andinformation on cash crop production and marketing is very low (non-existent).

Table 4.7 Adoption level of cash crop production at each scheme, 2015

Schemes	Irrigationarea (ha)	Cash crop cultivated	Land under cash crops	
			Area (ha)	%
Belebala	112	Sugar cane, onion,tomato, potato, garlic,citrus fruits, and coffee,banana, papaya, etc.	40	35.7
Tekeza	178	Pepper, onion	1	0.03

*Source:*Lalibela Woreda Agriculture Office, 2015.

According to the estimation made by the Lalibela Woreda Agriculture Office, about 35.7%of the total irrigation land in Belebalatraditional schemes isbeing utilized for cash crop production every year. As shown in Table 4.7, farmers have grown all types of cash crops with an intensity of three times a year for vegetables.

However, due to its comparative advantages, sugar cane is found to be the dominant cashcrop grown in the scheme. Some of the advantages of sugar cane over the othervegetables as mentioned by farmers and extension workers are:

- has no strict time of harvesting, not perishable, easy to harvest, pack and transport;
- high productivity per unit area and can generate good price (4 to 5 Birr per stalk) at farm get price;

- its ability to coppice after harvesting or possibilities of planting its residues;
- easy to manage and watering, relatively less labor intensive;
- High disease tolerance ability, not damaged by animals, birds, etc.

Sugar cane is harvested on a period of one year and six months but it can stay on the field up to two years without quality change on the cane stalk. This provides a chance for irrigators to sell their cane at a time of good price. Other perennial crops have got high market demand.

However, due to small land holding size per households, such crops are often planted aroundhomestead and along earth canals.

Table 4.8 Major cash crops produced by sample households (2014/15)

Irrigation Schemes	Vegetables		
	Potato(Quintal)	Onion (Quintal)	Sugar cane (Stalks)
Belebala	2.3	0.8	1570*

Source: Household Survey Results, September 2015.

* The average amount of sugar cane produced is computed from the amount of Birr generated from the sale ofsugar cane and calculated at a rate of 4-5 Birr per stalk (average price reported).

In Belebala irrigation scheme, the major cash crops produced are Potato, Onion and Sugar cane. Sincethe scheme is located near to Lalibela town (32km), farmers also produce tomato, cabbageand pepper with an intensity of three cropping per year.

Among the two irrigation schemes considered in this survey, Tekeza is the least performing scheme in terms of cash crop production. Farmers were asked why they prefer toproduce maize rather than other cash crops. In response to this question, many of themexplained that they do not have the necessary knowledge and experience to cultivatevegetables. There are also other situations like settlement pattern, a culture of open grazingsystem in the dry season that is obstacles in this case. Due to historical and climatic reasons, peoples' home is located up the hills, which is about 10 km far away from theirrigation plots. Under such situation, they could not protect their garden from livestockdamage and possible thefts.

Figure4. 3Belebala irrigation scheme produced onion and harvest

The contribution of vegetables production to household food security is not only throughgenerating income to purchase other food items but also that diversification of crops at thescheme could diversify the diet composition and will improve nutritional status of irrigationhouseholds.

Figure4.4Belebala irrigation scheme produced tomato

4.5.1 Marketing of Cash Crops

When irrigation is done for cash crops, markets for the sale of produce at a reasonable pricehave been important to irrigation success. Due to lack of storage and transport facilities,perishable horticultural crops are highly sensitive for marketing situation. Vegetables andfruits produced are either sold at local market or transported to other markets by merchants.Lalibela town is an important local market for vegetables produced in the sample schemes.Other distant market places for sugar cane, onion and citrus fruits are Woldya, Sekota and Mekate towns to the North.

Table: 4. 9 Price of some major vegetables at local market (2014/15)

Vegetables	Unit	Price in Birr	
		Lower	Higher
Sugar cane	Stalk	4	5
Onion	Quintal	900	1000
Potato	"	400	500
Tomato	"	350	400
Cabbage	"	200	300

*Source:*Household Survey Result, September 2015.

Farmers have indicated that low and fluctuating price situation of vegetables has been themajor problem of irrigation farming. The terms of trade are always in favor of the buyers andfarmers lack the bargaining power. Since the demand for vegetables is limited in urban areasand as there are many vegetable producer schemes in the surrounding *Woredas*, there is ahigh competition for vegetable market. According to respondents, Potato and Onion aresuffering most from lack of market. Therefore, any future intervention in the promotion ofcash crop production should consider the issue of marketing and other necessary facilitieslike information, storage, farmers' organization, production diversity, consumer test, etc.

4.5.2 Backward and Forward Linkages

Irrigating farming can create economic backward and forward linkages if cash crops aresuccessfully adopted. Among the two schemes considered in this survey, the elements ofsuch economic linkages are observed in Belebala traditional irrigation schemes. Backwardlinkage

takes the form of creating and enhancing business activities for those dealing in farminputs and out puts. When this survey was conducted in September 2015, a merchant broughtpotato seeds from South Gonder (Debre-tabor) and sold it to irrigators in Belebala. Major cerealslike maize, Sorghumand wheat purchased by irrigators at local market are brought from theGojjam area, where some surplus production is available. Another positive development inBelebala irrigation is that a private businessmen supplies chemical fertilizer to irrigators andthey usually buy it on cash in hand basis. This is due to the fact that high value crops, whichare grown under irrigation, rely heavily on agricultural inputs such as fertilizer and pesticides.Sugar cane is a notable example here.

Forward linkages can occur mainly due to produced cash crops for the market purpose.Merchants come to Woldya from Lalibela, Kobo, Alemata and Mekele in the North to buysugar cane, onion, citrus fruits, hops (*Gesho*). This production of cropsfor sale has led to increased employment opportunities and improved standard of living. Asfood security at household level is usually caused by lack of purchasing power, irrigationbrings extra income to the farmers, thus enabling them to get access to food.

4.6Household Income and Its Sources

In normal times of proper production, the main sources of income for the rural households aregrain, sale of smaller animals, seasonal employment and performing diverse incomegenerating activities. Major source of income during the time of harvest (November-December) is from the sale of crops relatively at a low market price. After the food stockfrom main rain production is exhausted (usually around May and June), the main source of income is from the sale of animals and diverse income generating activities includingmigration to towns and other areas to the low lands. This has been the usual pattern of ruralhousehold income source in the study area. However, irrigation households have additionalincome source from the sale of cash crops.

For the purpose of this study, the total household income has been divided in to four groupsdepending on the source of the income generated. These include income from cash cropproduction, income from food crop production, income from sale of livestock and

incomefrom other sources. Only irrigation households generate income from cash crops production.Income from other sources in both cases refers to off-farm activities, which include incomefrom petty trade, wage Labors, sale of firewood, eucalyptus poles, etc.

Income from food crop production refers to the total value in Birr of the total food grainproduced with in 2014/15 cropping year. The average annual price of each grain at Lalibelamarket, which has been collected by Lalibela woreda Department of Trade and Industry wasused to value the food grain in to Birr (see annex table A1). Incomes from livestock productioninclude the cash generated from sale of animals, animal products and in some case profitreceived from fattening of oxen.

Household income in this study refers to the value in Birr of total annual agricultural production (food grainand cash crops), income from the sale of animals and animal products and income from off-farm activities asoutline in the survey questionnaire.

4.6.1 Income of Sample Irrigation Households

As shown in Table 4.10 below, the average income of irrigation households is Birr 9587.5 which is the sum of average income from cash crops, food grain, livestock sale and incomefrom other sources.

Table 4.10 Average yearly income of sample irrigation households (2014/15)

Income Source	Irrigation Households		Mean	% share
	Belebala	Tekeza		
Cash Crops	3330	1100	2215	23.1
Food Grain	2696	4973	3834.5	39.9
Livestock	2338	2080	2209	23.2
Others	1319	1339	1329	13.8
Total	9683	9492	9587.5	100

*Source:*Household survey, September 2015.

When we look at the comparison of the share of different sources, cash crop production aloneaccounts for about 23.1%of the total household income. But its' share is about 35%of household income in Belebala scheme. This shows how cash cropping areimportant to the

irrigation communities. Food grain production is the other major source ofincome for irrigation group which accounts for about 39.9%of the average income ofall households, but its share is 52%of the household income in Tekeza scheme. Thethird major source in this category is income from off-farm activities, which is dominated byincome from petty trade, sale of firewood (Tekeza) and eucalyptus poles (Belebala).Livestock production is reported to be the least source of income to irrigation households.This is due to the small number of livestock kept among irrigators due to shortage of feed andgrazing land.

4.6.2 Income of Sample Non-Irrigation Households

The average total income at non-irrigation households is Birr 5237.5, which is the sum of average income from food grain, livestock production and other off-farm sources.

Table: 4. 11 Average yearly incomes of sample non-irrigation households (2014/15)

Income Source	Non Irrigation Households		Mean	% share
	Belebala	Tekeza		
Food Grain	2790	3885	3337.5	63.7
Livestock	900	800	850	16.22
Others	1120	980	1050	20.08
Total	4810	5665	5237.5	100

*Source:*Household survey, September 2015.

The major share of the total household income in this case comes from food grain productionas shown in the Table 4.11 above. Its share is 53%and 74%of thetotal household income of Belebala and Tekezaschemesrespectively. This showsthat non-irrigation households are highly vulnerable to drought and rain shortfall situation asmore than 64%of their subsistence comes from rainfall dependent crop production.

According to the survey result, the second major source of income for non-irrigationhouseholds' comes from off-farm activities. The study also identified that about 78.3 %of non-irrigation households were reported to have participated in one or other form inoff-farm activities. These include wage labors, petty trade (of any form), sale of firewood,weaving, guarding, etc. On the other hand, the contribution of livestock production to nonirrigationhousehold income is the least

of four major sources. This happened perhapsbecause of farmers have sold many of their livestock to withstand the frequent drought andfood shortage situation in the area. Lack of grazing land and shortage of animals' feed hasbeen the major problems of animal rearing in the study area.

4.6.3 Participation of Households in off- farm Activities

Rural household income can be supplemented by other income generating activities otherthan the crop production and animal husbandry. During the group discussion, farmers haveidentified that rich households in the community are those who have two oxen and rent (sharecropping) the land of other poor families. This shows that how off- farmactivities are important means of existence in areas of low agricultural income and droughtsituation. Moreover, the survey result shows that about 46.6 %and 78.3 %ofsample households from irrigation and non-irrigation groups have been engaged in off-farmactivities.

Table: 4. 12 Distribution of sample respondents by their participation in off-farm activities

Activities	Participants by Household Group	
	Irrigation n=60	Non-Irrigation n=60
Wage Labors	11	17
Petty Trade	9	15
Sale of fire wood	8	13
Weaving	-	2
Total	28	47

*Source:*Household survey, September 2015.

Households from both groups have participated in off-farm activities. Since nonirrigation households stay idle throughout the long dry season (slack period), the majority of them are involved in wage labor and petty trading of cereals and livestock. This indicates that irrigation development enhances gainful self-employment and increase carrying capacity of agricultural land. According to the respondents, off-farm activities have been adopted to minimize the risk of food insecurity and as one of the coping mechanisms to the existing low agricultural income and frequent food shortages.

4.6.4 Eucalyptus as a Cash Crop

In Belebala area schemes, many farmers have planted eucalyptus as a boundary plantation along their farms or homesteads. According to some of them, they choose to plant eucalyptus around their farmlands because of its fast and straight growth, its capacity to grow on poor soils and its good market value. In a market day in Belebala, it wasobserved that farmers receive 50 to 60Birr per pole for traders who transported it to Mekele in the north. However, many farmers have agreed that eucalyptus plantation should not be encouraged due to its negative impact on moisture content and fertility of the soil.

4.6.5 Comparison of Income of Irrigation and Non-Irrigation Households

The following can be used to see the difference between the irrigation and nonirrigation households in the level of annual average income they generate. The mean income of irrigation households is 75% more of the mean income of non-irrigation households.

Table 4.13 comparison of average yearly income of the two groups of sample households (2014/15)

HouseholdGroups	HHs	MeanIncome	StDev	T-Value
Irrigation	60	9581.3	4790.65	4.743***
Non-Irrigation	60	5237.5	2618.75	

Source: Computed from the result of Tables 4.10 and 4.11, *** Shows significance at 1% level

The result of Table 4.13 revealed that the annual mean income of sample irrigation households was Birr 9587.5 whereas for non-irrigation households the same was Birr 5237.5. The annual mean income of the two groups of sample households shows significant difference at 1-% level. This significant difference in income generated by the two groups of households is mainly due to high income of irrigators from increased cereals production and sale of cash crops. Moreover, about 9 (45 %) in Belebela and 7 (35%) in Tekeza irrigation sample households reported that they have involved in fattening of oxen that enables them to generate additional income. Year round availability of feed from irrigation crops residue (Straw and stalk) help them to engage in oxen fattening business.

One the other hand, income from other sources is lower for irrigation households than non-irrigation ones. As already shown in Table 4.12, the numbers of sample respondents who have been involved in off-farm activities are significantly higher among the non-irrigation groups than the irrigation households. This shows that the majority of non-irrigation households have participated in off-farm activities to earn additional income and supplement their low agricultural performance.

The above findings have an important implication on the role of small-scale irrigation to improve the living standard and food security status of rural households. Increasing crop production and income from the sale of cash crops have enabled irrigators to feed their family throughout the year from their own resources. Thus, if successfully preformed and cash crops are adopted, small-scale irrigation development is a viable intervention to break the vicious circle of rural poverty and food insecurity.

4.7 The Effect of Irrigation on Asset Base of Households

The asset base includes both liquid and production assets. The liquid assets include domestic (furniture), tools and different forms of valuables. Productive assets on the other hand include primarily livestock. The asset base plays a crucial role with regard to the productive capacity of the households and also as a safeguard in the recurrent periods of food shortage. In this section, it has primarily been believed that small-scale irrigation will help to reduce household asset liquidation during the time of drought or food shortage.

4.7.1 Livestock Holding

Livestock is the single most important productive asset for households in the study area both as working tools (for plugging and transporting) and as an asset to protect against periods of food shortage. The loss of livestock, especially ox is critical as it not only ruins the asset base, but also impoverishes the general productive capacity of the households. Thus, the ownership of livestock is often used as an indicator for wealth.

Small animals like sheep and goats play a major role for rural households. Mostly they are sold to settle various household expenditures such as tax, social obligations, etc, and also to

purchaseof food items in time of food shortage. Donkeys are the most important types of domestic animals in the study area that petty trade activities are made possible due to the ownership of this animal. They are source of rural transport system and about 37.5 per cent of the sample households in both groups' maintained donkeys.

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

Therefore, irrigation households could possess more livestock than non-irrigation households especially in areas where availability of grazing land and animals feed are a problem. Thus, the result of this survey as summarized in the table below more or less proves the latter argument.

Table 4.14 Livestock holding of the two groups of households by type

Kebeles(Schemes)	HH Group	Number of Livestock owned by sample HH					
		Oxen	Cow	Other Cattle	Sheep	Goat	Donkey
Belebala	Irrigation	29	15	5	-	7	3
	Non-Irrigation	28	14	17	-	9	6
Tekeza	Irrigation	42	10	6	-	5	6
	Non-Irrigation	21	9	8	14	11	4
Total	Irrigation	71	25	11	-	12	9
	Non-Irrigation	49	23	25	14	20	10

*Source:*Household survey Result, September 2015.

As indicated in the previous discussion shortage of grazing land and animals feed is a critical problem as all available lands are converted into croplands. As a result of this, the number of livestock resources per household is very small and concentrated on the two important livestock

such as oxen and milking cow. Currently animals are grazing on marginal land and feed a crop residue that is piled at the homestead after harvesting. As can be seen from the table 4.14 above, irrigation households have maintained large number of oxen and cow than their non-irrigation counterparts. Since irrigation is a year round farming activity, having at least one ox is an essential input of farming activities. Some of the sample irrigation households have also been involved in ox fattening business. As mentioned before, income generated from the sale of cash crops enable irrigators to invest on productive asset such as oxen. Moreover, crop residues ofirrigation production provide year round animals feed that enable irrigators to keep more cattle stock than non-irrigation households.

On the other hand, non-irrigation households have maintained larger number of sheep and goats. These animals are totally dependent on grazing and browsing for their feed. The other reason will be that non-irrigation households maintain small animals as possible in order to sell them so as to buy food at the time of food shortage and to cover other household expenditures.

4.7.2 Oxen Holding

In North Wollo in general and in LalibelaWoredain particular, shortage of draughtoxen is a problem of subsistence agriculture. According to the data obtained from theZone Department of Agriculture, 40.5 %of households in the Zone have no oxand only 40 %of households have owned one ox.An ox-sharing practice is one of the major means of solving ox shortage whereby ahousehold shares his/her oxen with other partner for a particular workday. However, intraditional agriculture where the calendar should perfectly match with rainfall regime,ox-sharing practice hinders to cultivate the available land timely being one of the causesof low production and household food insecurity.

Table 4.15 Comparison of oxen holding and distribution of oxen by the two groups sample households

Distribution of Sample HH by Oxen Ownership	Household Groups		T-Value
	Irrigation	Non-Irrigation	
Total Population of Oxen	71	49	1.993**
Average Holding Per HH	1.183	0.81	
Oxen Ownership			
0	10	20	
1	28	31	
2	20	9	
3	1	-	
Total (HH)	60	60	

Source: Computed from Table 4.14, ** Shows Significant at 5% level

As shown in Table 4.15, the average ox holding per sample irrigation and non-irrigation households is 1.183 and 0.81 respectively, shows significant difference at 5% level. For both groups of sample households, oxen population is about 46.7 %of the total cattle population owned. The Table further shows that 35 %of irrigation and 15 % of sample non-irrigation households owned adequate farm oxen to cultivate their own land. According to the survey result, only 16.7 %of irrigation and 33.3 % of non-irrigation sample households have not owned ox. When we compare it from the zone average families who have no ox (40.5 %), the sample *kebeles*are found in a better position for both groups. However, when we consider the difference in absolute term, sample irrigation households could maintain 22 oxen more than that of non-irrigation households. This reveals that income and additional production obtained from irrigation enable farmers to maintain their own oxen so as to improve their agricultural performance and food availability at household level.

4.7.3 Other Household Assets

In the survey questionnaire, an attempt was made to look in to liquid asset bases of households focusing on the items like TV, Wristwatch, bed (wood and metal) and housing conditions (corrugated iron roofing). The intention was to examine the wealth status of households in relation to having access and no access to irrigation in the study area. However, the survey result revealed that there is no meaningful difference between the two groups of household in terms of

possession of any of the items listed except for the housing condition. For instance, 11 (18.3%) households from irrigation and 8 (13.3%) from sample non-irrigation groups have possessed TV. The same is reported to wristwatch. Concerning the housing unit of sample households 26 (43.3 per cent) of irrigation and 14 (23.3 per cent) of non-irrigation sample households have possessed corrugated iron roofing housing unit respectively. This implies that most of the income generated from the sale of cash crops is being used to purchase food items and for other household expenditures (tax, social obligations, etc.) rather than invested on household valuable assets.

4.8The Role of Irrigation to Reduce Households Dependency on Food Aid

The eastern Amhara region in general and North Wollo in particular are drought prone areas and have frequently been affected by drought induced famine. Available data show that production from rain fed farming is decreasing due to scarcity of the rain, high erosion problem and decreasing fertility of the soil, small land holding size per household and lack of essential production assets. As a result, a substantial number ofhouseholds have been found under chronic food insecurity situation and are partlydependent on food aid for their subsistence. The main objective of small-scale irrigationdevelopment in the area is to increase the carrying capacity of the land throughsustainable and intensified production system so that farmers will be self-sufficient infood from their own production.

At present, food aid is distributed to the needy people through the *Kebele*administration. However, targeting (screening) procedure was found to becontroversial. According to the information obtained from *Kebele*officials, the selectioncriteria of households for food aid include those who have no produce due to rainshortage, flood hazard, households who have no oxen, the disabled (elder peoplepermanently sick), large family with small land holding size, etc. Food aid is given forthe months of June- October, mainly to fill in the food requirement gap of householdsup to the next harvest in November. For the able bodies, it is given through laborcontribution in Employment Generation Schemes (EGS) organized by the *Kebele*administration.*Kebele*officials have also reported that irrigation households are not officially entitled tofood assistance. Even if some of them are considered, only one-person ration (12.5 kg) ofwheat is given per month per households.

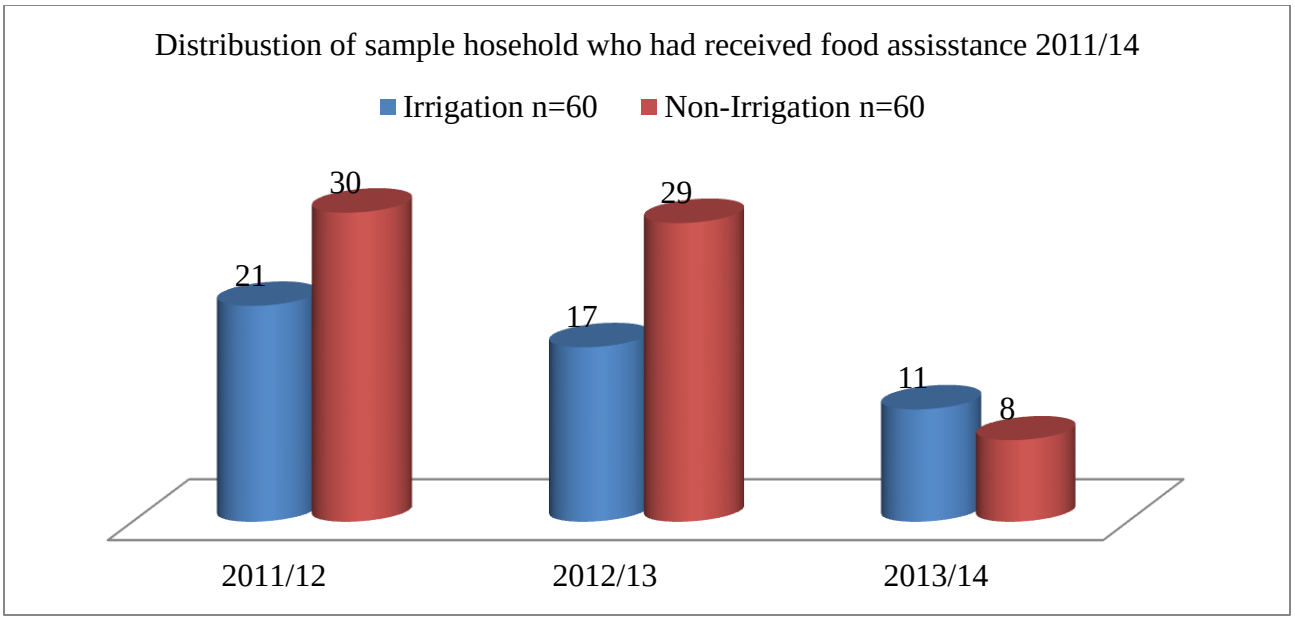

Figure 4.5 Distribution of sample respondent who had received food assistance (2011/12-2013/14)

*Source:*Household survey Result, September 2015.

As shown in the figure above, on the average 27 %of irrigation and 37%ofnon-irrigation sample households have reported that they had received food aid withinthe consecutive four years. However, the researcher felt that the response (number ofHH who received food aid) might have been exaggerated in both groups due to deep-rooteddependency syndrome developed in the community. Moreover, there is aproblem of reluctance among *Kebele*officials to discriminate between households withinthe community and a tendency to distribute small quantities of food aid over largenumber of people. Thus, the above survey result might not be taken as strong evidenceto draw conclusion.

However, in the history of drought in the area, it has been reported that thosehouseholds who have access to irrigation have survived better than their non-irrigationcounter parts. One respondent in Belebala scheme has tried to recall thesituation in 1977 drought and said that:

…"*I remember that there was no rainfall during the whole summer(Kiremt) of 1976 E.C. In Belebala locality we produced maize andsorghum using irrigation water and saved both our lives and ourcattle. Many people in the surrounding area either died or leftanywhere in search*

for food. In March 1977 E.C relief aid reached toBelebala and saved from further death and out migration of the people."

The above evidence shows that drought situation might not affect irrigators directlybecause of constant supply of irrigation water throughout the year. Therefore, food aidshould not be given to the ability farmers who have access to irrigation in order toeffectively utilize the available resource and avoid dependency syndrome.

4.9 Problems of Small-Scale Irrigation Development

Irrigation is a special case of agricultural development in which technology intervenes to provide soil moisture and reduce water stress on crops. Therefore, irrigationdevelopment helps to sustain and increase agricultural production, especially in areaswhere rainfall is unreliable and fail to come. However, the performance andeffectiveness of both traditional and formal small-scale irrigation schemes areconstrained by multidimensional problems ranging from individual farmers' attitude toinstitutional arrangements.

Some of the major identified problems are:

• Small size of irrigation plots, especially in Belebala traditional scheme is reported to be themajor bottleneck of irrigators to maximize their benefit from irrigation. Additionally,variation in plot holding size among farmers is also reported to be the cause of pooroperation and management in Tekeza scheme. Those farmers who own small plot size(0.04 hectare) are reluctant to participate in maintenance work and protection of schemeinfrastructures. On the other hand, those households who have larger plot size (0.5hectare) are suspicious about their tenure right over the irrigation land in relation to thenew development. They often think that the government would develop the area and thentake away the land.

• Poor coordination between institutions dealing with irrigation development. For example,there are no clear-cut duties and responsibilities between the Department of Agricultureand Department of Service Cooperative and Promotion. Construction engineer underSAERAR are experts in design and construction, but have no specialist training inirrigation management which require a detail understanding of agricultural process andthe farming community. Moreover, the

Department of Agriculture is poorly equippedwith resources and has to cover both rain fed and irrigated areas. The department is oftenin short of specialist expertise in irrigated agriculture. Therefore, this divided pattern oforganization has had unsatisfactory result.

• Frequent damage of traditional temporary structures (Diversion weir and earth canals) ofBelebalaarea traditional irrigation schemes. It has been reported that valuable farming time of the community tends to be lost at the end of each rainy season on repair andconstruction work.

• Inadequate farmers' knowledge and experience in irrigated agriculture resulted in poorperformance of Tekeza formal irrigation scheme. In addition to this, there is no propersupport structure in agricultural extension for irrigated agriculture from agriculture office.The path to irrigated agriculture, for a farmer who has participated in rainfall farming all his life can be long and financially painful, if he is left to his own device and to the "trialand error" methods of learning (FAO 1982).

• The assumption of change to double or multiple cropping made possible by theavailability of water is not frequently met in reality. According to the informationobtained from the extension workers, in Tekeza scheme some farmers are unwilling toundertake more intensive cultivation. If the simple needs of peasant farmers can be metfrom other means (like selling of firewood, relief assistance, rain fed production, etc.)they may not be willing to work on irrigation during the hot weather months of the dryseason.

• Lack of necessary inputs such as vegetable seeds, fruit seedlings, and chemical fertilizerand in some cases credit services. A problem related to fertilizer is not only lack of supplybut also the minimum amount deliver is 50 kg, which a single farmer could not utilize atonce due to small size plot holding. This need farmer to form a group, in order to haveaccess to fertilizer and in most of the cases failed to be effective.

• Water distribution is clearly of central importance in any irrigation schemes. In the entirescheme considered by this survey, there has been no standardized irrigation (watering)interval to each crop cultivated. Water is distributed by turns of equal duration throughoutthe irrigation season simply following spatial order of plots, regardless of the

cropcultivated. Thus, poor distribution system and inefficient use of water resource is thecommon feature of small-scaled irrigation schemes in the study area.

• Lack of market and marketing facilities has been proven to be a problem for small holderirrigators in the study schemes. Lack of storage facility and absence of proper functioningfarmers' organization all have contributed to low farmers bargaining power especially onthe marketing of potato, onion and tomato.

• Settlement pattern of the area is found to be an obstacle of irrigation development inTekeza scheme. Due to historical and climatic reasons (prevalence of malaria and forsecurity reason) peoples' home is located up on the hills about 10km far away from theirirrigation land. Moreover, there has been a culture of open grazing system during the dryseason, which resulted in canal and crops damage by livestock. All these unfavorablecultural and settlement constraints forced farmers to cultivate cereals (maize and *Teff*)instead of high value cash crops, which need close monitoring, and follow-up.

5. CONCLUSION AND RECOMANDATION

5.1 Conclusion

This study had paid significant emphasis on overall socio-economic impact of small-scaleirrigation and its contribution to household food security in Lalibela*Woreda* of NorthWollo Zone, Amhara Region. In this study attention was given to the role of irrigation inincreasing agricultural production, income and asset possession of households in the studyarea.

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

Despite the low productivity and recurrent drought in the study area, it is believed that cropproduction can be sustainable through development of small-scale irrigation schemes in areasendowed with perennial water sources. The result of this study also reveals that in the historyof drought in the area, those households who have access to irrigation have survived betterthan their non-irrigation counterparts.

Since the 1980's the Ethiopian government has given attention to small-scale irrigationdevelopment as a means of combating drought situation and improving household foodsecurity. Accordingly, 14 small-scale irrigation projects with a total irrigation area of 1947hectare of land have been developed in North Wollo Zone since 2014.

The finding of this study shows that traditional irrigation schemes in Belebala area have a betterperformance than government sponsored schemes at Tekeza. Performancelevel of irrigation schemes is viewed from the point of effectiveness of management andoperation of the scheme, cropping intensity and adoption of high value cash crops. Factors,which determine the performance of irrigation schemes, are identified as farmers' groupcohesion, strength of the water committee, location proximity of the schemes to people'shome, past experience of farmers in irrigation agriculture and farmers commitment toundertake intensive agriculture.

With regard to the management and operation of the schemes, each of two sample schemeshave irrigation water committee, which use a system of group by-laws to manage and run thescheme. Water committees in Belebalaschemes are effective in running theschemes properly than in Tekeza scheme. Social cohesion among irrigators and effectivenessof water committee to enforce group by-laws are found to be an essential element of goodperformed schemes.

In an effort to tackle the chronic problem of food insecurity in the country, the Ethiopiangovernment is implementing a new agricultural extension package program targeted toachieve accelerated and sustainable growth in crop production. However, the adoption andeffectiveness 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 theuse of small-scale irrigation can reverse this tendency in which 58.3 per cent of irrigationhouseholds have reported, as they are regular users of fertilizer.

Generally, all the two irrigation schemes studied have positive impact on the living standardand food security status of irrigators. The contribution of the schemes has been explained inthe following areas:

• Irrigation households have been able to produce two times a year using the irrigationwater. In areas of small plot size per household and unreliable rainfall situationirrigation helps farmers to increase and sustain their agricultural production and foodavailability at household level. More importantly, irrigation harvest reaches at a verycritical period of June, when the food stock from main rain production is exhaustedand the price of food grain is very high at the market. Moreover, the production ofhigh value cash crops by the irrigation schemes means that farmers are noweffectively participating in the mainstream economy of the region.

• The study also revealed that irrigation household in Belebala schemeshas been able to make twice as much annual income as their non-irrigationcounterparts. This high income was mainly due to cropping pattern being practicedincorporate high value horticultural crops. Therefore, small-scale irrigation isproviding gainful self-employment for participants and enabled them to be income secured and better access to food.

• Asset base plays a crucial role with regard to productive capacity and agriculturalperformance of rural households. Cash income generated from irrigation farming hasbeen an important source of investment on productive assets of rural households.According to the result of the survey, 83.3% of irrigation households could maintainone and more than one ox. Moreover, 85% of irrigators in Belebala traditional schemeshave managed to construct corrugated iron roofed houses using income derived fromirrigation. These all are good indicators of wealth and living standard of irrigators inthe study area. Thus, we could conclude that, if successfully performed and cash cropsare adopted small-scale irrigation development is a viable intervention to breakthrough the vicious circle of rural poverty and food insecurity.

5.2 Recommendation

Finally, based on the findings of the study, the following issues are identified for futureconsideration for the effective performance of irrigation schemes in the long run.

- ✓ Coordination of all relevant institutions involved in small-scale irrigation development is important during the planning, implementation and operationof schemes.
- ✓ Training for irrigators in water management, maintenance of infrastructure,general crop production and marketing are also necessary for goodperformance of schemes.
- ✓ Beneficiary farmers should participate through the project planning andimplementation processes.
- ✓ Demonstration works such as irrigation methods, irrigation scheduling ondifferent crops, cropping intensity and input utilization rates should be carriedout in each of the irrigation schemes.
- ✓ Provision of inputs and credit service, some form of incentive for model farmers and disincentives for farmers who are not cultivated their irrigationplots are also important to increase effectiveness of irrigation schemes.

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APPENDIX

APPENDIX A: TABLES OF CROP VALUES AND CONVERSION FACTORS

Table A1: The price of crops and vegetables in 2014/2015

Crop Type	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	Jun.	Average Price
Teff	890	870	806	840	810	815	825	910	845.75
Barely	515	514	480	505	507	511	540	599	521.375
Wheat	600	640	645	653	670	685	689	695	659.625
Maize	500	511	490	495	505	470	475	545	498.875
Sorghum	538	532	522	505	470	475	480	495	502.125
Beans	697	640	620	655	645	680	688	695	665
Peas	812	815	835	844	820	812	860	890	836
Tomato	500	436	470	465	425	433	515	520	470.5
Onion	710	712	716	740	753	732	729	728	727.5
Potato	444	415	423	450	420	460	480	485	447.125
Kosta	342	350	376	410	390	410	420	411	388.625
Cabbage	383	405	408	394	399	400	815	420	453

Source: Lalibela Woreda Agricultural office (2015)

APPENDIX B: SURVEY QUESTIONNAIRE

Annex I

Questionnaire Designed to Assess Food security situation of irrigation Household in Belebala and Tekeza Irrigation Schemes in Lalibela*Woreda* of North Wollo Zone, Amhara Region.

Identification

Enumerator's name _____

Name and code of PA _____

Village _____

Date of Enumeration _____

Personnel and Household Data

Sex of the Respondent (HH head): 1) male 2) Female

Age of the Respondent: _____ year

Marital Status:1) Married 2) Not married 3) Divorced 4) Widow 5) Separated

Educational Status:1) Illiterate 2) Read and write3) Up to grade 4 4) above grade 4

Size of the Family: _____, children under 15 yearsold _____.11 to 15 years_____ 16 to 64 years_____, 65+ Years _____

Agricultural Production, Income Sources and Asset Owned

How much is the land holding size of the family? (Timed,Hectare)

1) Non-irrigable _____ 2) Irrigable _____ 3) Total _____

Do you have grazing land?1) Yes 2) No

Have you cultivated the total of your irrigation of during the dry season (*Bega*)?

1) Yes 2) No

If no to the above question, what were the reasons? (Circle the answers)

1) Labors shortage in the family 2) Lack of oxen3) Lack of seeds 4) Lack of credit

5) Enough production from main rain cultivation

6) Others, specify _____

Did you hire labors in operating your irrigation farm?1) Yes2) No

Ifyes to the above question, on the average for how many working days each growing season

_____

Using irrigation, which cereals you often grow?

1) Maize2)*Teff*3)Sorghum 4)Wheat 5)Others, specify_____

What was your total production from 2014/15 irrigation?

N.O	Cereals	Unit	Amount produced
1	Maize		
2	*Teff*		
3	Sorghum		

If you sold any type of your production, indicate the amount and income received:

N.O	Cereals	Unit	Amount Sold	Income in Birr
1	Maize			
2	*Teff*			
3	Sorghum			
4	Wheat			
5				
Total				

Indicate the total of your agricultural production in 2014/15*Meher* season:

N.O	Cereals	Unit	Amount produced
1	Maize		
2	*Teff*		
3	Sorghum		
4	Wheat		

If you sold any of your produce from *Meher*production, indicate type, amount sold and money received:

N.O	Cereals	Unit	Amount produced	Income in Birr
1	Maize			
2	*Teff*			
3	Sorghum			
4	Wheat			
5	Barely			
6	Pulses			
Total				

Did you produce enough for family consumption from *Meher*and irrigation?

1) Yes 2) No

If no to the above question your production is enough for about ____ month's consumption.

How do you fill the gap between you production and food need?

1) Borrow cereals 2) Borrow money 3) Relief assistance4) Engage in extra activities (petty trade, wage labors, etc) to generate income5) others, specify

_____

Which cash crops (vegetables) you have grown using irrigation? (Circle as many as apply)

1) Sugar cane 2) Onion 3) Garlic 4) potato

5) Vegetables (cabbage, carrot, tomato, pepper) 6) Chat

7) Others, specify_____

Why do you prefer to grow such crops? (Answer(s) the question)

1) Better price 2) good production 3) high disease tolerance4) Easy to cultivate and manage 5) Seeds available6) Others, specify

_____

On the average, what percentage of your irrigation plot is allotted for cash crops eachyear?

1) Full of my plot 2) ½ 3) 1/3 4) ½ of my plot

Indicate the type and amount of cash crops you produced and the income you gainedin 2014/15 production year?

N.O	Cash crop	Unit	Amount produced	Total Sale in Birr
1	Sugarcane			
2	Garlic			
3	Potato			
4	Vegetables			
5	Chat			
6	Banana			
7	Onion			
Total				

Did you purchase cereals (food grain) for your family consumption in 2014/15?

1) Yes 2) No

Indicate the total money you spent to purchase food grain in a year: _____ Birr.

Did you rent your irrigable land in 2014/15?

1) Yes 2) No

If yes to the above question, what amount of your holding?1) All of my holding 2) ½ 3) 1/3 4) 1/4

Indicate the amount of money or produce (if in kind) you received: _____

What were your sources of income other than agricultural production in 2014?

N.O	Activities	Income in Birr
1	Labors wage	
2	Petty trade (of any type)	
3	Weaving	
4	Pottery	
5	Local beverages	
6	Sale of firewood, charcoal	
7	Sale of crop residue (straw, hay, stalks)	
Total		

Indicate the number of cattle and other animals you own.

1) Oxen _____ 6) Mule _____2) Caws _____ 7) Horse _____

3) Other cattle _____ 8) Donkey _____4) Sheep _____ 9) Hens _____

5) Goats _____

Did you get income from the sale of animals and animal products in 2014? If yes,Indicate type and total sale.

N.O	Animals/products	Sold Number/amount	Sold Income in Birr
1	Oxen		
2	Goats		
3	Mule		
4	Horse		
5	Donkey		
6	Other cattle		
7	Sheep		
8	Caw		
9	Hens		
10	10 Milk/butter		
11	11 Hide and skin		
12	12 Hire of oxen (days)		
	Total		

If you have no ox (oxen), how do get access to oxen?

1) Hire 2) Oxen for labors exchange 3) Other, specify _____

Do you have the following household goods and valuables? (Circle as many as apply).

1) Radio 2) Wrist watch 3) Leather shoes 4) Fanos5) Kerosene store 6) Blanket 7) Bed (metal, leather)

What is the condition of your housing unit(s)?1) Corrugated iron sheet roofed and one hut 2) Corrugated iron roofed3) Two huts (grass roofed) 4) One hut

Agricultural Extension and Credit Service

In the past five years have you applied chemical fertilizer on your farm?

1) Yes 2) No

If yes to the above question, when do you used?1) Main rain (Meher season) 2) With irrigation 3)On both seasons

If fertilizer is used in irrigation, to which crops you often applied?

1) Cereals 2) Vegetables 3) Both

If no to the above question, what were the reasons?

1) Lack of supply 2) Shortage and delay in supply3) High price (expensive) 4) Lack of credit service5) Fear of debt burden 6) others, specify _____

In the past five years have you used improved seeds? (Cereals)

1) Yes 2) No

If no to the above question, what were the reasons?

1) Lack of supply 2) Poor quality of seeds3) High price 4) Fear of debt burden5) Lack of credit service 6) others, specify _____

Are you regular user of credit service for your agricultural actives?

1) Yes 2) No

Support from Other Sources/Copping Mechanisms

Were you affected by the 1984/85 drought?

1) Yes 2) No 3) I do not remember

Were you affected by the 1993/94 famine?

1) Yes 2) No

Did you receive food assistance during the following years?

Year	2012/13	2013/14	2014/15
Response			

Annex II

Questionnaire Designed to Assess Food security situation of non-irrigation Household in Belebala and Tekeza Irrigation Schemes in Lalibela*Woreda* of North Wollo Zone, Amhara Region,

Identification

Enumerator's name _____

Name and code of PA _____

Date of Enumeration _____

Personnel and Household Data

Sex of the Respondent (HH head): 1) Male 2) Female

Age of the Respondent: _____ year

Marital Status:1) Married 2) Not married3) Divorced 4) Widow 5) Separated

Educational Status:1) Non-literate 2) Read and write3) Up to grade 4 4) above grade 4

Size of the Family: _____, children under 10 years age _____.11-15 age _____, 16-64 age_____, 64+ _____

Agricultural Production Income Sources and Asset Owned

How much is the land holding size of the family? (Timed, Hectare, ortheir local units)_____

Do you have grazing land or a field to cut and collect hay?1) Yes 2) No

Did you hire labors in operating your farm?1) Yes 2) No

If yes to on the above question the average for how many working days each growing season?

_____

Have you ever cultivated during the Belg season? (February-March)1) Yes 2) No

If yes to the above question what was the total amount you produced in 2014/15Belg season?

N.O	Cereals	Unit	Amount produced
1	*Teff*		
2	Sorghum		
3	Maize		
Total			

If you sold any type of your production, indicate the amount and income received?

N.O	Cereals	Unit	Amount produced	Income in Birr
1	*Teff*			
2	Sorghum			
3	Maize			
Total				

What was your total agricultural production in 2014/15*Meher*season?*

N.O	Cereals	Unit	Amount produced
1	*Teff*		
2	Sorghum		
3	Maize		
4	Wheat		
5	Pulses		
Total			

* Total production is the sum of both from farmer's own land and sharecropping, rent land (it any) and the amount indicated should be the result of just after threshing.

If you sold any of your production in the year, indicate the amount sold and money gained.

N.O	Cereals	Unit	Amount sold	Total sale in Birr
1	*Teff*			
2	Sorghum			
3	Maize			
4	Wheat			
5	Pulses			
Total				

Did you grow any type of vegetable during the main rain for marketing purpose?

1) Yes2) No

If yes to the above question, indicate the total of your production, amount sold and total sale in Birr in 2014/15.

N.O	Crops (Vegetables	Unit	Amount Produced	Amount sold	Total sale in Birr
1	Potato				
2	Garlic				
3	Pepper				
4					
5					
Total					

Did you produce enough for family consumption from *Meher*and *Belg*during normal years?

1) Yes 2) No

If no to the above question, your production is enough for about _____ month's consumption.

How do you fill the gap between your production and food need?

1) Sale of livestock 2) Borrow cereals3) Borrow money 4) Relief assistance5) Engage in extra activities to generate income (petty trade, wage labors, etc)6) Others, specify _____

Did you rent your land to get income under normal years?1) Yes 2) No

What were your sources of income other than agricultural production in 2014?

N.O	Activities	Income in Birr
1	Labors wage	
2	Petty trade (of any type)	
3	Weaving	
4	Pottery	
5	Local beverages	
6	Sale of firewood, charcoal	
7	Sale of crop residue (straw, hay, stalks)	
Total		

Indicate the number of cattle and other animals you own:

Oxen _____ 6) Mule _____ Caws _____ Horses _____Other cattle _____ Donkey _____Sheep _____ 9) Hens _____Goat's _____

Did you get income from the sale of animals and animal products in 2014? Pleaseindicate your total sale.

N.O	Animals/products	Sold Number/amount	sold Income in Birr
1	Ox		
2	Cow		
3	Other cattle		
4	Sheep		
5	Goat		
6	Mule		
7	Donkey		
8	Caw		
9	Hens		
10	Hire of oxen		
Total			

If you have no ox, how do you get access to oxen?

1) Hire 2) Oxen for labors exchange3) Oxen for crop residue exchange 4) others, specify _____

Do you have the following household goods and valuables? (Circle as many as apply).

1) Radio 2)Wrist watch 3)Kerosene 4) Store 5)Blanket 6)Bed 7)Leather shoes 8)Fanos

Agricultural Extension and Credit Service

In the past five years have you applied chemical fertilizer on your farm?1) Yes 2) No

If no to the above question, what were the reasons?

1) Lack of supply 2) Lack of credit service 3) Shortage and delay in supply 4) Variability of the rainfall5) High price of fertilizer 6)Fear of debt burden 7) others, specify _____

In the past five years, have you used improved seeds?1) Yes 2) No

If not the above question, what were the reasons? 1) Lack of supply 2) Lack of credit service 3) Fear of debt burden 4) High price 5) Poor quality of seeds 6) Others, specify _____

Are you regular user of credit service for your agricultural activities?

1) Yes 2) No

Support from Other Source/Copping Mechanisms

Were you affected by the 1984/85 drought?

1) Yes 2) No 3) I do not remember

Were you affected by the 1993/94 food crisis?1) Yes 2) No

Were any of your relatives gone to resettlement during 1984/85?1) Yes2) No

Did you receive food assistance during the following years?

Year	2012/13	2013/14	2014/15
Response			

Annex III

Checklists for Key Informants and Focus Group Discussion

The following checklist were used with questions to guide in the informal interviews andgroup discussions that held with irrigation scheme farmers, knowledgeable individuals,Development Agents, Experts and Woreda and Kebele officials.

About Irrigation Schemes

How old is the irrigation scheme?

How big the irrigation scheme?

How many households have plots on the scheme?

Can I access the list of irrigators?

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

How the management and operation of the scheme undertaken?

Is there an irritation management committee? What is its role? How effective is it? How is itelected?

Who decides the cropping programmed in the irrigation scheme?

Is there any by low of the irrigation scheme? Can I access the document?

How construction and maintenance activities to be per formed on the scheme? (Ditches and diversion weir)

What types of fees do farmers on the scheme pay?

Do farmers in the scheme have access to dry land plots?

Which institutions one in one way or other involved in the scheme?

Area covers under different crops during the 2014 irrigation seasons?

Which cash crops are grown on the scheme?

How the marketing of cash crops undertaken? How much was farm get price for such crops in2014?

Were irrigations affected by the 1973/74, 1984/85 and recent droughts?

In your opinion, what is the impact of the scheme on the irrigators in general?

What are the major problems encountered by farmers on this scheme?

General Socio-Economic Conditions

Who is rich and who is poor? What are the criteria for categorization of households into rich, middle, poor and very poor applied by the local community?

How was the land distribution undertaken?

What criteria are used for allocating relief food?

Who determine these criteria? Are there any problems encountered?

What criteria are used in delivering credit service?

How many households is currently used credit?

What are the major activities undertaken by households to generate incomeother than agriculture?

Why farmers often refused to use fertilizer?

Where people often went to find work during the bad years?