INDRA GANDHI NATIONAL OPEN UNIVERSITY

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CONTRIBUTIONS OF SMALL SCALE PUMP IRRIGATION TO HOUSEHOLD FOOD SECURITY IN DUGDA DISTRICT, EAST SHOA ZONE, CENTRAL RIFT VALLEY, ETHIOPIA

A THESIS SUBMITTED TO INDIRA GANDHI NATIONAL OPEN UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF DEGREE OF MASTER OF ART IN RURAL DEVELOPMENT (MARD)

BY

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Arsi Negelle, Ethiopia

DECLARATION

I hereby declare that the Dissertation entitled **CONTRIBUTIONS OF SMALL SCALE PUMP IRRIGATION TO HOUSEHOLD FOOD SECURITY IN DUGDA DISTRICT, EAST SHOA ZONE, CENTRAL RIFT VALLEY, ETHIOPIA** submitted by me for the partial fulfillment of the M.A. in Rural Development to Indira Gandhi National Open University, (IGNOU) New Delhi is my own original work and has not been submitted earlier either to IGNOU or to any other institution for the fulfillment of the requirement for any course of study. I also declare that no chapter of this manuscript in whole or in part is lifted and incorporated in this report from any earlier work done by me or others.

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CERTIFICATE

This to certify that Mr. SIRAGE HUSSEIN OUMER student of M.A (RURAL DEVELOPEMNT) from Indira Gandhi National Open University, New Delhi was working under my supervision and guidance for his Project Work for the Course MRDP-001. His Project Work Entitled" **CONTRIBUTIONS OF SMALL SCALE PUMP IRRIGATION TO HOUSEHOLD FOOD SECURITY IN DUGDA DISTRICT, EAST SHOA ZONE, CENTRAL RIFT VALLEY, ETHIOPIA''** *which he is submitting, is his genuine and original work.*

Place: ---------- *Signature*----------

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Abbreviations and Acronyms

ADLI: Agricultural Development Lead Industrialization

CRVE: Central Rift Valley of Ethiopia

EPA: Environmental Protection Authority

FAO: Food and Agricultural Organization

FGD: Focus Group Discussion

GDP: Gross Domestic Product

GTP: Growth and Transformation Plan

Ha : Hectare

HFBM: Household Food Balance Model

Kcal: Kilocalories

KII: Key Informant Interview

MARC: Melkassa Agricultural Research Centre

MDG: Millennium Development Goal

MOARD: Ministry of Agriculture and Rural Development

MOFED: Ministry of Finance and Economic Development

MOWR: Ministry of Water Resource

NGO: Non-Government Organizations

PASDEP: Plan of Accelerated and Sustained Development to End Poverty

PSNP: Productive Safety-Net Program

RCWDO: Rift Valley Children and Women Development Organization

SEDA: Sustainable Environment and Development Action

SPSS: Statistical Package for Social Science

SSI: Small Scale Irrigation

TLU: Tropical Livestock unit

UN: United Nations

UNDP: United Nations Development Program

USD: United State Dollar

WFP: World Food Program

WUA: Water Users Association

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CHAPER ONE: INTRODUCTION

1.1 Background of the Study

The number of food insecure people in the world remains unacceptably high. According to FAO (2012) about 870 million people, representing 12.5 percent of the global population, or one in eight people are estimated to have chronically undernourished in terms of dietary energy supply in 2010–12. According to the same source, the vast majority of these, 850 million, live in developing countries where the prevalence of undernourishment now is estimated at slightly fewer than 15 percent of the population and the current assessment update (based on data and methodology improvement) pegs the undernourishment estimate for developing countries at slightly more than 23.2 percent of the population in 1990–92. It further stated that the current reduction of undernourishment in terms of number and proportion is almost on the track to achieve MDG in Asia and Pacific and in Latin America and the Caribbean while the improvement in Sub-Saharan Africa is less rapidly where the rate has reduced from 32.8% to 26.8 but the number of undernourished people has increased from 170 million to 234 million between 1990-92 and 2010-2012.

Ethiopia is one of the poorest countries in the world and in Sub-Saharan countries, ranked at 174th out of 187 countries on the UNDP Human Development Index results made in 2011. It is country with a GDP per capita adjusted with the Purchasing Power Parity of USD 971 compared to almost USD 2 000 average for Sub-Saharan countries (FAO/WFP, 2012). With more than 80 million inhabitants in 2010, with annual population growth of more than 2 percent, Ethiopia is the most populous nation in Eastern Africa and it will have more than 120 million people by 2030 (EPA, 2011). The number of chronically food insecure people and the number and

prevalence of undernourishment is highest in Ethiopia when compared with most of other Sub-Saharan African countries. FAO/WFP 2012 stated that, launched in January 2005, the Productive safety Net Programme (PSNP) currently targets 7.57 million chronically food-insecure rural people and it is expected to reach 8.3 million people in 320 districts by 2015 in eight regions. According to FAO, 2012, the number of people undernourished in Ethiopia is remained almost 34 million over a period of 1990-92 to 2010-12 while only the rate of undernourishment reduced from 68% to 40% in the period.

According to the Growth and Transformation Plan (GTP), agriculture is the mainstay of the Ethiopian economy as it accounts for about 41.6% of the GDP in 2009/10. Moreover, it provides employment for 84% of the population, raw material for industries and items for export (MOFED, 2005). It generates foreign currency for import of essential inputs and food for the fast growing population (Makombe et al 2007). The dominant agricultural system in Ethiopia is smallholder production of cereals under rain-fed conditions, with a total area of approximately 10 million hectares (World Bank 2006).

Despite its importance, Ethiopian agriculture could not play the roles expected from it significantly. Due to lack of water storage and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year and hence there are frequent crop failures due to dry spells and droughts which has resulted in a chronic food shortage currently facing the country (Seleshi et al, 2007). Average productivity of three main cereal crops in Ethiopia is 17 quintal per hectare (MOFED, 2010). Ethiopian Agricultural production is extremely vulnerable both to climatic condition and to the disruptive war and civil conflicts (IFAD 2006; cited in Abdulselam 2011). According to the same source, recurring droughts leave poor farming families without food crops, causing periodic famine. As noted by

the World Bank (2006) report: “The very structure of the Ethiopian economy with its heavy reliance on rain-fed subsistence agriculture makes it particularly vulnerable to hydrological variability. Its current extremely low levels of hydraulic infrastructure and limited water resources management capacity undermine attempts to manage variability”. The food production status of the country has to be doubled till 2025 as compared with the current level of production so as to meet the food demands of the growing population of Ethiopia; otherwise, continuing with the current production momentum, supplying the required amount of food for the population will be a challenge at large (Seleshi et al, 2005).

Investing in agriculture is one of the most effective strategies for reducing poverty and hunger and promoting sustainability (FAO, 2012). Irrigation development has been identified as an important tool to stimulate economic growth and rural development, and is considered as a cornerstone of food security and poverty reduction in Ethiopia (Fitsum et al, 2009). The same authors indicated that irrigation contributed approximately 5.7% and 2.5% to agricultural GDP and the overall GDP, respectively, during the 2005/2006 cropping season. By the year 2009/2010, the contribution of irrigation to agricultural GDP and overall GDP is estimated to be approximately 9% and 3.7%, respectively. The Ethiopian government adopted and is implementing an economic policy of Agricultural Development Lead Industrialization (ADLI). ADLI aims at boosting agricultural productivity and production and thereby improving the rural livelihoods which enhances demands for goods and services. Following the Agricultural Development-Led Industrialization (ADLI) strategy and building on PASDEP achievements, the GTP has the priority to intensify productivity of smallholders and strongly supports the intensification of market-oriented agriculture, for domestic and export markets and promotes private investments (MOFED, 2010).

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 anticipated role that irrigation could play in the economic development strategy is stated in the water sector strategy as follows,

Irrigation development is key to the sustainable and reliable agricultural development, and thus for the overall development of the country. In order to ensure food security at the household level for Ethiopia's fast growing population, more small-, and medium- and large-scale irrigation infrastructure needs to be developed. Such development could also generate an externally marketable surplus that would earn the much needed foreign exchange and provide the required raw material to the local industries (MOWR, 2001).

The Central Rift Valley of Ethiopia (CRVE) is one of the areas where food shortage happens in the country and large investments in irrigation development are taking place for the production of stable and cash crops. In CRVE, Rapid population growth resulted in encroachment of marginal and environmentally sensitive areas contributing to declining soil fertility, erosion, low crop yields, feed shortages, progressive land degradation, and reduction of areas under fallow (Kamara et al., 2002). In CRVE, especially in Dugda district, the government and development NGOs are supporting smallholder farmers to improve their livelihoods through promotion of small scale pump irrigation schemes. The schemes get water either from Lake Ziway or shallow wells in the lake catchments.

However, the contributions of small scale pump irrigations to household food security are not yet studied very well in CRVE area. Most of the studies seen in the area are concerned with the technical aspects of small scale irrigations. So far, studies on analyzing contribution of irrigation on food security improvement have been focused on large-scale irrigation schemes which were

established and managed by the state (Selesh et al., 2005). Hence the intension for undertaking this research is to contribute to fill the existing gaps.

1.2 Statement of the problem

Agriculture is the mainstay of the Ethiopian economy in terms of income, employment and generation of export revenue. Its contribution to GDP, although showing a slight decline over the years, has remained very high. From among the sub-sectors of agriculture, crop production is a major contributor to GDP accounting for approximately 28% in 2005/2006 (Fitsum, et al., 2009). The same authors in the same year stated that heavy reliance on rain fed agriculture, during conditions of very variable rainfall and recurrent droughts, affects agriculture and, hence, has adverse effects on the economy of Ethiopia. The productivity of the agricultural sector is very low and lags behind the population growth rate resulting in food insecurity (Mengistu, 2008). Ethiopia, once expected to be the bread basket of Africa is now suffering from a severe shortage of food for its citizens and chronic poverty. According to MOWR, 2009, many districts located in Rift valley lakes basins are in food deficit and farmers are unable to feed their families due to low levels of agricultural productivity, rainfall variability, small holding size and poor soil fertility.

The Government of Ethiopia is implementing agriculture-led industrial development strategy to spearhead the country's development program. Irrigated agriculture is included as one of the major contributors to this development strategy (Makombe et al., 2011). It has been clearly and loudly stated that if Ethiopia is to feed its ever increasing population, lessen risk of catastrophes caused by drought, continuous and extensive effort need to be made towards developing irrigated agriculture and intensifying agricultural production. Hence, to enhance the use of country's water

resources under 5 year (2010/11-2014/15) Growth and Transformation Plan (GTP), expansion of small scale irrigation has been given priority while due attention has also been given to medium and large scale irrigation to the extent possible (MOFED, 2010).

In an effort to solve the challenges of food insecurity through small-scale irrigation, one of the concern areas is the semi arid area of CRVE, where the study area is located. In the plain area of Lake Ziway catchment small scale pump irrigations are utilized by smallholder farmers. In the Dugda district out of the 36 rural villages 17 of them have access to the irrigation water that can be pumped either from the lake or shallow well in nearby catchment. Development NGOs, government and other development actors are supporting vulnerable smallholder farmers to get access to the irrigation in order to improve their food security. The farmers produce both food crops and cash crops. As irrigation development is often associated with cash crops, irrigation investments' contribution to food security is often questioned.

On the other hand, Seleshi et al (2005) noted that large scale irrigation technologies are relatively well known in Ethiopia while smallholder irrigations which have the potential to achieve household food security are new. The same source mentioned that pump projects are not very successful as farmers cannot immediately handle the technology or affording the costs and difficulties related with operation and maintenance. This indicates that there is a need for studying the differences made by smallholder pump based irrigations on household food security condition.

There are limited studies on the contributions of smallholders' especially small pump irrigations to household food security. Though there are limited number of studies, most of these studies give due attention to the technical aspects of the irrigations and are most of the time on large scale irrigations. Some of the available studies are done out of the rift valley area and gravity

irrigation of river diversion. For example, Getinet (2011) conducted study on linking small-scale irrigation and household food security in northeastern highlands of Ethiopia, Alawuha Small-Scale irrigation which is based on river diversion. The context of Rift Valley is different from other parts of the country because of variation in climatic condition and socioeconomic set up of the population, and the challenges and opportunities of pump based irrigations and gravity based river diversions are also different in establishment and operation and maintenance of the schemes. These dissimilarities t differently affect the household food security of the population in CRVE. Therefore, the aim of this research is to explore the contributions of small pump irrigations to household food security and the challenges related with their utilization.

1.3 Objective of the study

The general objective of the research is to study the contributions of smallholder Irrigation to household food security in CRVE taking small pump irrigation schemes in Dugda district of East Shoa zone as a case, and generate information that help policy and strategy development. With this general frame the specific objectives of the research are:

1. To assess the food security status of small pump irrigation user and non user households in the study area
2. To assess the contributions of small pump irrigation to household food security in the study area
3. To assess the technical and institutional challenges of small pump based irrigations in assuring food security

1.4 Research questions

1. What is the status of household food security of small scale pump irrigation users and non users?
2. What are the contributions of small scale pump irrigation to household food security?
3. What are the technical challenges of small scale pump irrigation development and management?
4. What are the institutional challenges of small scale pump irrigation development and management?

1.5 Significance of the study

The study compares the food security status of small pump irrigation user and non user households in terms of average daily per capita availability. It also explores mechanisms and level of contribution of small pump irrigations to household food security in the study areas. Moreover, the technical and institutional challenges of the pump based irrigation that are affecting household food security are studied. The limited previous studies were focused only on gravity based river diversion small and large scale irrigations. This study is concerned with small pump irrigations managed by stallholder farmers and it generates information that will be used by policy makers and development actors.

Thus, the study discovers key actions and knowledge to be used by development actors in planning and executing development programs, research and extension activities and in making necessary policy decisions in relation to the pump based irrigation technology in the study area and elsewhere in the country. Besides the above advantages, since there is no any research which was done on the contributions of small scale irrigation based on pump technologies in the

study area, this particular research generates information on small pump irrigation contributions to household food security in Dugda district in particular and in CRVE in general.

1.6 Limitations of the Study

Though this particular research is completed, it is not without limitations. Due to time and financial resource constraint, this study was confined to only three Kebeles of Dugda district in East Shoa Zone and sample was restricted to 100 households which may affect the quality of the research. Because of the same reason, it was based on the conditions of one year in terms of crops production and household food security and the scenarios of smallholder farmers' food security overtime were not investigated to understand the whole picture of the sampled households.

Since the respondents are illiterate, they do not keep the records of their produce, the income they gained from the product and expenditures for the production, the information collected was only based on the mere memory of the household heads.

1.7 Definitions of concepts and terms

Smallholder farmers: Farmers owning a total farmland size up to 5 hectare in use right holding**.**

Small Scale Irrigations: Irrigation schemes that have a commend area of less than 200 hectare. Smallholder irrigation and small scale irrigation are interchangeably used in this study

Small scale pump irrigations: Irrigation schemes that have a commend area of less than 20 ha and use pump for water lifting in contrast to gravity based irrigations.

Food Security: Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life

Food secure household: Households having per capita grain availability per day of greater than or equal to 2100 kcal

Food insecure households: Households having per capita grain availability per day of less than 2100 kcal

Irrigation user households: Households which have access to irrigation farm through use right holding

Non irrigation user households: Households which do not have access to irrigation farm through use right holding

Technical Challenges: Technical challenges are concerned with constraints related to gaps in technical knowledge and skill of the irrigation user farmers, the inherent problems of the quality of inputs and biophysical environment of small scale pump irrigation schemes

Institutional Challenges: The institutional challenges are gaps and setbacks posed by non functionality of rules and regulations governing access, rights, claims, services; institutional capabilities and opportunities to effectively use small scale pump irrigation schemes.

1.8 Organization of the paper

This research report is organized in to six chapters. Chapter one consists of introductory part where concepts and status of food security, challenges of agriculture and irrigation as solution,

definition of important terms and concepts, statement of the problem, objectives, research questions, and the scope and limitations of the study are described in detail. Chapter two deals with detail review of literatures that are related to the research topic and objectives. The third chapter deals with the design and methodologies of the study. Chapter four mainly explains the background of the study area. The fifth chapter consists of the analysis and discussion of the findings of the study and their interpretation. The final sixth chapter comprises conclusion and recommendations of the study. All necessary annexes and bibliographies are annexed at the end of the research report.

CHAPTER TWO: LITERATURE REVIEW

2.1 Definitions and Concepts of Food Security and Smallholder irrigation

2.1.1 Food security

Food security, or rather insecurity, is a multifaceted and intricate concept, variously and progressively defined and interpreted (Messay 2012). Some literatures take the emergency of the concepts and initiation of concerns for food security back to 1943, after the first Conference of FAO (George et al, 2009), while many others agree that the concerns and concepts have become international agenda since 1970s in concrete terms (Maxwell, 1996; Clay, 2002; FAO,2002, Degefa ,2005).

Degefa, 2005 noted that famine and malnutrition were common phenomena in human history before the introduction of the concept of 'food security' about three decades ago. The emergence of the concept of food security very much relates to the political (policy) concerns towards combating an increasing malnutrition and famine at global level. The early years of the 1970s was due time when the proportion of the malnourished world population was higher than ever before. This was why the UN/FAO took the initiative to call upon the world nations to take part in the First World Food Conference in 1974, which adopted the Universal Declaration on the Eradication of Hunger and Malnutrition which proclaims that: 'Every man, women and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties' (ibd).

The concept of food security has been reformulated many times since mid- 1970s when the term began to be used on a regular basis and it progressively developed and expanded along with the growing incidence of hunger, famine and malnutrition in most parts of the world as noted in Messay (2011). In the 1974 World Food Conference, food security was defined as: 'Availability

at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices'(UN, 1975; Maxwell, 1996) Maxwell and Smith (1992) noted that at this stage the concept of food security considers it as the availability of sufficient food supply at global, national and regional levels and the focus was, therefore, on the aggregate supply of food in the world market to meet the demand for it. According to this definition, a nation that can make sufficient food available from either domestic production, import or a combination of the two was regarded as attaining food security (Degefa, 2005). The 1974 world food conference emphasized that the increment in food production (especially in developing countries), enhancement in consumption and distribution of food, and building a system of food security to alleviate food crises (UN, 1975).

However, the availability of food at larger scale hardly guarantees food security achievement at household or individual level (Messay, 2011; Degefa, 2005). In other words, increased food production and abundant supply at macro levels is a necessary but not sufficient condition to ensure that all households and individuals are able to secure their food needs. In this regard, ensuring access to food, not merely increasing food supplies, should be regarded as critical component of food security. In his most influential study, Sen explained food insecurity occurs not because there is not enough food, but because people do not have access to enough food (Amartya Sen, 1981 cited in Messay, 2011). Based on this, other definitions of food security were adopted by the UN organizations in 1980s and 1990s. For Example: FAO, 1983 cited in Messay (2011) defined food security as 'Ensuring that all people at all times have both physical and economic access to the basic food that they need.' Moreover, World Bank, in its Poverty and Hunger report of 1986 further elaborated the concept of food security as 'Access by all people at all times to enough food for an active and healthy life.'

The document of the World Bank (1986) further classify the definition of food insecurity in to two; chronic and transitory. Chronic food insecurity is a continuously inadequate diet caused by the inability to acquire food and it affects households that persistently lack the ability either to buy enough food or to produce their own. On the other hand transitory food insecurity is a temporary decline in a household‘s access to enough food and it results from instability in food prices, food production or household incomes-and in its worst form it produces famine.

The wider and complex definition of food security was also given by World Food Summit of 1996 as ‘Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life’. Many researchers have adopted this definition to their works in Ethiopian context (Messay, 2011). Since this definition of food security is referred in wide array of research, it is adapted for this particular study

According to many literatures (Anne, 2009; Schmidhuber & Tubiello, 2007) food security can generally be assessed in terms of four conceptual dimensions such as Food Availability, Food Access, Food Utilization and Food Stability. These are explained very briefly in the following paragraphs:

Food Availability: relates to the availability of sufficient food. It means that food is physically present because it has been grown, processed, manufactured, and/or imported. For example, food is available because it can be found in markets and shops; it has been produced on local farms or in home gardens; or it has arrived as part of food aid. This refers to all available food in the area, and includes fresh, as well as packaged food.

Food Access: refers to the way in which different people obtain available food. Normally, the way of accessing food is through a combination of means. This may include: home production,

use of left-over stocks, purchase, barter, borrowing, sharing, gifts from relatives, and provisions by welfare systems or food aid. Food access is ensured when everyone within a community has adequate financial or other resources to obtain the food necessary for a nutritious diet.

Food Utilization: is the way in which people use food. It is dependent upon a number of interrelated factors: the quality of the food and its method of preparation, storage facilities, and the nutritional knowledge and health status of the individual consuming the food. For example, some diseases do not allow for optimal absorption of nutrients, whereas growth requires increased intake of certain nutrients.

Food Stability: relates to individuals who are at high risk of temporarily or permanently losing their access to the resources needed to consume adequate food. To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity)

2.1.2 Household food security

The food security analysis can be at national, regional, community, household and individual level. As collecting precise information for each individual might be impossible or too costly, especially in country like Ethiopia, household level analysis is an option which is widely practiced in food security research (Getinet, 2011). Unlike the cases of 1970s, the focus of the concept of food security is shifted to questions of access to food at household and individual level in 1980s and since then it has been conceptualized that the adequacy of food supply at the global or national levels does not guarantee access to food at community or household levels (Maxwell and Smith, 1992). In other words, increased food production and abundant supply at macro levels is a necessary but not sufficient condition to ensure that all households and

individuals are able to secure their food needs (Messay, 2011). As noted by the same author, Amartya Sen (1981) argues that ensuring access to food, not merely increasing food supplies, should be regarded as critical component of food security and in his most influential study; Sen explained food insecurity occurs not because there is not enough food, but because people do not have access to enough food which shifted recently the focus and unit of analysis with regard to food security from the global and national to household and individual levels. These indicate the paramount importance to look at the concept of food security and measure its status at household level.

The concept of household food security is a more recent development and the bulk of literature dated from 1980s equating national food security with food self-sufficiency is a problem that needs to be clearly understood. Many countries those used to be considered as self sufficient in food were found to be food insecure due to the fact that they either lack an efficient food system or the capacity to the level of food entitlement. This indicates that attaining macro-level food self sufficiency does not ensure the achievement of household food security (Getahun, 2003 cited in Getinet, 2011). This indicates that food security strategy has to address household level food production and investment in food production and storage to be effective.

Sen (1981) in Messay, 2011 argues that a household may suffer from food shortage in a region or country where adequate food is available. Under these circumstances, food shortage becomes a matter of 'lack of access' that is the inability to produce or purchase food. Sen also argues that households become food insecure because of failure in entitlement: 'endowment' or 'exchange' entitlement failure (Degefa, 2005). The author mentioned that there are four possible sources of entitlements such as production-based, trade-based (exchange), own-labor, and inheritance and transfer. Getinet (2011) elaborated these entitlements such that production based entitlement describes the right to own what one produces with one's own resource, trade based entitlement

describes what an individual can buy with the commodities and cash they own; inheritance or transfer entitlement refers to the right to own what is willingly given by others as remittance, bequest, as well as transfer from state such as social security, pensions and food distribution. All these entitlements give an individual control over resource which they can use.

2.1.3 Household food security measurement

Food security is a concept that has evolved considerably over time and there is much literature on potential household food security indicators. There are approximately 200 definitions and 450 indicators of food security (Hoddinott, 1999). The same author in the same source mentioned that Maxwell and Frankenberger (1992) lists 25 broadly defined indicators, Riely and Moock (1995) list 73 such indicators, somewhat more disaggregated than those found in Maxwell and Frankenberger and Chung et al. (1997) note that even a simple indicator such as a dependency ratio can come with many different permutations. They list some 450 indicators. The authors noted that consequently, an important methodological problem for development practitioners is to determine which indicators are appropriate, given the project being proposed.

Since food security is influenced by different interrelated socioeconomic, physical, institutional and political factors, it requires understanding of multidimensional contexts of the target area (Getinet, 2011). Hence, combining both qualitative and quantitative household data sources in studying of food security activities allows knowing holistic nature of the study area comprehensively as argued by (Degefa, 2006)

The analysis of food security status at different levels requires investigation of four core components: physical availability of food, economic and physical access to food, utilization and stability (sustainability) the other three dimensions over time (FAO, 2008 cited in Messay 2012).

Jacobs (2009) recommended three general indicators: food availability, food consumption/ access and a composite food security indicator. These are summarized in the following table 1.

Table 1: Household Food Security indicators

Indicator /measure	**Focus**	**Examples**
Food availability	National or household agro-food output/supply	Food balance sheets
Food consumption/access	Food demand or consumption at the household level (ways in which institutions regulate access to food)	Household expenditure models; food expenditure ratio; income elasticity
Composite food security	Simultaneously captures each dimension in a single indicator	Poverty Hunger Index; Rose-Charlton Indicators; Food Security Gap Index

Sources: Jacobs, 2009.

Jacobs(2009) elaborated the three indicators as food availability indicators focus on national food supply, yet pay scant attention to individual nutritional status, food expenditure and access indicators measure the monetary value of food as a proxy for food consumption, but often exclude individual nutritional status (or other anthropometric measurements) composite indexes incorporate all the available dimensions of food security into a single index, but the weights attached to components of the index might misrepresent their values in practice.

Food balance sheet presents a comprehensive picture of the pattern of country's food supply during a specified reference period (FAO, 2001). The Food Balance Sheet is a widely used tool for analyzing the overall food supply situation and estimating import requirements of a country

or region. The original Food Balance Sheet was introduced by FAO under its Global Information and Early Warning System for Food and Agriculture based in Zimbabwe in 1994 ((SADC, 2009 cited in Getinet 2011).

Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and henceforth used by different researchers in this field (Messay, 2010). As the food balance sheet tool has been used by many scientific studies to measure the contribution of development projects mainly in agriculture sector, Getinet (2011) also used to assess the household food security status of Gubalafto Woreda of North Wollow Zone. Hence, this study used the model to compute the food security status of households in the study area.

2.1.4 Definitions and concepts of smallholder irrigation

Irrigation is defined as the artificial application of water onto cropland for the purpose of satisfying the water requirements necessary for growing different crops and plays a key role in stabilizing food production in a number of countries by either supplementing or replacing the need for natural precipitation for the purpose of food production (FAO, 1997).

Irrigation is categorized as small, medium or large-scale depending on the area irrigated, scale of operation and type of control or management. But the criteria for this category may vary from country to country. For example, in India the irrigation scheme of 10,000 ha is classified as small while in Ghana the largest irrigation is 300 ha (Smith, 1998 cited in Lemma, 2004).

Irrigation is one means by which agricultural production can be increased to meet the growing food demands in Ethiopia (Seleshi et al, 2005). According to the same authors and source, increasing food demand can be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land, and increasing cropping intensity. Expansion of the area under cultivation is a finite option, especially in view of the marginal and

vulnerable characteristic of large parts of the country's land. Increasing yields in both rain-fed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are the most viable options for achieving food security in Ethiopia (ibd).

Irrigation projects in Ethiopia are identified as large-scale irrigation if the command area is greater than 3,000 ha, medium-scale if it falls in the range of 200 to 3,000 ha, and small-scale if it covers less than 200 ha (Dessalegn, 1999; Fuad, 2002; Selehi et al, 2005).

The small-scale irrigation schemes in Ethiopia are understood to include traditional small-scale schemes up to 100 ha and modern communal schemes up to 200 ha. Traditionally, farmers have built small-scale schemes on their own initiative, sometimes with government technical and material support. They manage them through their own water users association or committees. The farm size varies between 0.25 ha and 0.5 ha. Water users associations have long existed to manage traditional schemes. They are generally well organized and effectively operated by farmers who know each other and are committed to cooperating closely to achieve common goals. Typical associations comprise up to 200 users who share a main canal or a branch canal. They may be grouped into several teams of 20 to 30 farmers each. Such associations handle construction, water allocation, operation and maintenance functions (as noted by Seleshi et al, 2005 based on information from MOWR, 2002). Small pump scale irrigations which are considered in this study are classified under small scale irrigation in terms of scale but use pump to generate power for water lifting in contrast to gravity water diversion irrigation systems

2.2 Irrigation and Food security condition in Ethiopia

Though Ethiopia has 12 major river basins with an annual runoff volume of 122 billion cubic meter of water and an estimated 2.6 billion cubic meter of ground water potential which generally amounts to 1707 cubic meter of water per person per year, a relatively large volume;

due to lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year (Seleshi et al., 2005). Frequent dry spells and droughts exacerbate the incidence of crop failure and hence food insecurity and poverty.

Given the amount of water available, even while passing through the semi-arid, arid, and desert areas, it is evident that the promotion of water development technologies, especially irrigation, at both small and large-scales, can provide an opportunity to improve the productivity of land and labor and increase production volumes. Based on the present indicative information sources, the potential irrigable land in Ethiopia is about 3.7 million hectares. This figure is believed to be on a lower side, and could change as more reliable data emerge particularly on small-scale irrigation potential (Seleshi et al., 2007).

Estimates of the irrigated area presently vary, but range between 150,000 and 250,000 hectares less than five percent of potentially irrigable land (Seleshi et al., 2005). These figures clearly indicate the extent and magnitude of the need for accelerated development and management of the available water resources of the country for irrigation. Hence, given the rapidly growing population in the foreseeable future, these resources will have to be tapped and harvested in order to attain food security, overcome the effects of climate change and variability, maintain sustainable industrial growth and improve the overall standard of living of the people of Ethiopia (Seleshi et al, 2007).

Domestic food production has failed to meet national requirements, and the number of food insecure people has been increasing particularly since mid 1970s. For the last three and half decades (1974-2009), for instance, the livelihoods of some 4.71 million people per annum had been affected mainly by drought induced food shortage calamities. As a result, with an average

food scarcity of 637,000 metric tons per annum from 1974-2009, Ethiopia has become increasingly dependent on international aid (MOARD, 2009 cited in Messay, 2011).

Therefore, achieving improved food security at country level can be met through efficient food production and distribution system throughout the country. To overcome national food insecurity, the economic policy of a country has to give due emphasis to tackling household food insecurity at grass root level through increased production as much as possible. The emphasis on agricultural production is, however, one aspect of approaching food insecurity at household level; it is an urgent action to be taken to ensure the right to food for Ethiopian citizen. Hence, agricultural development policies should encourage farmers to adopt packages of new agricultural technologies with focusing in using of SSI mainly for food crop production system to maximize household food security (Tsegaye & Tamene, 2005 cited in Getinet, 2011).

2.3 Empirical studies in irrigation and household food security

2.3.1 Contribution of irrigation to household food security

The studies on contribution of irrigation through enhancing production, farm income improvement and diversification, and creation of rural employment are available to some extent mostly out of the study area. However, the empirical studies on the contribution of irrigation to household food security measured in terms of calorie acquisition are highly limited and this is more or less none for small pump irrigations managed by smallholder farmers.

Irrigation development and management has diverse benefits. The production frontier for the rain-fed system of farmers with access to irrigation is higher than that of rain-fed farmers without access to irrigation (Godswill Makombe et al., 2011). Irrigation also contributes to improvement in farm income. Fitsum et al (2009) showed in their studies conducted on selected irrigation schemes that irrigation generates an average income of approximately USD 323/hectare under

smallholder-managed irrigation systems compared to an average income of USD147/hectare for rain fed systems.

A study made in socio-economic assessment of two small-scale irrigation schemes in Adami Tullu Jido Kombolcha district showed that irrigation schemes increased households' income compared to situation before implementation of the schemes and thus contributed to improvement of household food security status (Mengistu, 2008).

Irrigation leads to an increase in yield per hectare and subsequent increases in income, consumption and food security. (Chamber 1994, in Abonesh et al 2008) , based on some empirical studies noted that reliable and adequate irrigation increases employment, i.e., landless laborers as well as small and marginal farmers have more work on more days of the year, which ultimately contributes to food security

Muduma (2001, cited in Lijalem, 2011) found that smallholder irrigation has brought many successes to farmers. Some of the successes are here below:

- Crop yields and farmer incomes under smallholder irrigation can increase many folds with irrigation.
- Crops unknown to communal farmers started to be grown under irrigation.
- Smallholder irrigators are able to grow high-value crops both for the local and export markets, thus effectively participating in the mainstream economy.
- Farmers in successful irrigation schemes have acquired physical assets (improved Housing, farm implements, furniture, and electrical appliances) and their standard of living has improved substantially.
- Irrigation schemes provided an alternative source of employment to the rural people, thereby discouraging rural to urban migration

A study by Hussain et al (2004) cited in Abonesh et al (2008), also confirms that access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This in turn opens up new employment opportunities; both on-farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas.

2.3.2 Challenges of smallholder irrigation systems

As the case for food security contribution measured in kilocalories, the challenges of pump irrigation systems are almost not well studied. Lejalem (2011) in his study of irrigation in Gedeb catchment of East Gojam Zone indicated challenges such as agricultural extension services were inadequate; market service was constrained by different factors such as lack of all weather roads; transport services; lack of information; cheap market prices for products; constraints of farm credit due to lack of collateral and complex bureaucracy, poor water governance by the water users, varying degree of water scarcity due to stream drying ,cracking of head dam and diversion of water near the head dam; and percolation and seepage problems .

Study conducted by Bedru (2004) on small scale irrigation users peasant horticulture in Dugda Bora and Adami Tullu Jiddo Kombolcha Woredas of East Shewa Zone indicated diseases, insect pests, irrigation water failure, timely unavailability of inputs, shortage of credit service, inadequate agricultural extension service, lack of adequate knowledge about irrigation agronomic practices, poor field management, inadequate market information on supply and demand of horticulture as major limitations.

Lemma (2004) in his study result of Smallholders' irrigation practice and Issues of community management of two irrigations of Eastern Oromia found that the majority of irrigators' farmland is under rain fed cultivation and little is only cultivated by applying irrigation water due to

shortage of water as well as inefficient irrigation water management. The author further noted that in efficiency in water management by community, mono cropping and market competition among producers, farmers' limited power to bargain with traders since they deal individually and their being remained price takers. Lack of inter cropping and crop rotation that contributed to under utilization and production inefficiency in study area, weak committee members in undertaking their responsibilities and legal entitlement of WUAs which did not help them to get special advantage than other schemes that did not get this title were also mentioned as challenges of the irrigations under that study. The author summarized the challenges as agronomic, organization and management, institutional and policy related constraints.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Universe of the study and sampling

The research was conducted in Central Rift Valley of Ethiopia, where vulnerability to food security is high. The sampling procedure followed for this study was a multi stage sampling procedure. Firstly, Dugda district was purposely selected as it is where the researcher has prior work exposition and has better knowledge of the local context including cultural set-up, languages, norms and values. Secondly, out of the total 36 villages found within the Dugda district, 17 were selected based on the availability of small scale pump irrigation schemes. Thirdly, out of the seventeen villages three: Abbino Gabrael, Wayyo Gabrael and Doddota Dembel were selected purposely based on the suitability of the villages for the researcher to easily collect the primary and secondary data. Moreover, the accessibility of the villages in terms of transportation was considered to select these three villages. In the fourth stage the total households of the three villages, 1346 including 305 irrigation users and 1041 non irrigation users were identified as universe from the district Agriculture office. Fifthly, separate lists of irrigation user and non irrigation user households were collected from respective village office. From the list based on the proportion 50 irrigation user household and 50 non irrigation user households totally 100 sample households were selected using random sampling techniques considering the total sample determined for the survey . Accordingly, the procedure resulted in the following sampled households.

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Table 2: Distribution of sample households by their respective village

Stratum	Name of Village	Total household	Sample households
Irrigation user households	Abbino Gabrael	81	13
	Wayyo Gabrael	110	18
	Doddota Dembel	114	19
	Sub total	**305**	**50**
Non-user households	Abbino Gabrael	329	16
	Wayyo Gabrael	412	20
	Doddota Dembel	300	14
	Sub total	**1041**	**50**
Grand total		**1346**	**100**

Source: own survey (2014)

Though based on the number of the total households in the sampling frame, the respondents needed for the research are more; the study was carried out on 100 respondents by considering homogeneity characteristics of sample households.

3.2 Tools for data collection

The research used a combination of qualitative and quantitative data to get a comprehensive and holistic understanding of the intended results. Therefore, both qualitative and quantitative data was collected from primary and secondary data sources. Methods and techniques of data collection employed to gather data from primary and secondary sources are discussed below.

3.2.1 Primary data sources

3.2.1.1 Household survey

For the household survey, a semi structured questionnaire that contains both open and closed questions were developed to collect primary data from the 100 respondent household heads. First, the questionnaire was prepared in English and then translated in to local language. The questionnaire was tested before the final administration to check and modify it for validity and reliability. Experienced four enumerators were identified from the area and trained for two days including pretesting to minimize errors in data collection process. With minor modification of the original questionnaire based on feedback of field testing, the final version of the semi structured questionnaire was administered on selected sampled households of the three villages. The survey was conducted in February 2014.

3.2.1.2 Key informant interview

Key informant interview was conducted at both village level and at district level. At village level the interview was done with development agents of agriculture office, health extension workers and model farmers of both irrigation user households and non irrigation user households. At district level the interview was conducted with key stakeholders of irrigation development, food security, agricultural cooperative promotion, health office, Meki Batu Fruits and Vegetables Growers Union, RCWDO and SEDA staffs as additional source to explore qualitative information. General guiding checklist was used to conduct the interviews.

3.2.1.3 Focus group discussion

A checklist with open ended questions was prepared and guided the discussion to get information on overall existing and trends of socio economic situation of the study area with especially focus on small pump irrigation and household food security. The results obtained thereof were used for triangulation with other primary sources and secondary source data for discussions or to substantiate them. A total of three focus group discussions were conducted in each village. They were undertaken with larger community representatives, irrigation users and non users. The composition of both male and female and other social diversities were well taken in to consideration to get good information. The focus group was comprises of 7-12 people. The tool was directly administered by the researcher himself so that to get information related to the research objectives and questions.

3.2.1.4 Observation

During this research work, field observation was employed as one of the research methods. It was carried out to collect information about the irrigation and food security condition observing what is going on in the area. It was also used to observe some of the challenges related with the development of pump irrigation scheme and management.

3.2.2 Secondary data sources

Secondary data were gathered so that to analyze the contribution of irrigation for household food security. The secondary data includes data regarding total grain production and cropping intensity followed by farmers with irrigated land and rain fed farmers at community level. The secondary sources of information included Dugda district and respective Zonal government annual reports, National and Regional official statistical abstracts, and researches undertaken in the area. The source also included national and international NGOs which are working or

supporting on efforts of irrigation development and food security improvement. Moreover, the data published in different books, policy documents about agricultural and irrigation development and food security and research journals was used to accomplish the research.

3.3. Data Analysis

After the data was collected from primary and secondary sources through various tools, it was analyzed through various data analysis methods. The quantitative data collected using survey was coded and entered in to computer software called Statistical package for Social Science (SPSS) version 16. Then the data was carefully cleaned. Microsoft excel was also used afterwards

For the quantitative data collected, descriptive statistics techniques of data analysis were employed. The statistical techniques include mean, percentage, standard deviation for presenting the results of the socioeconomic of sampled households. In addition to looking at the descriptive statistics mentioned above, where found necessary, Pearson Chi-square statistics was used to see differences of the socioeconomic variable between irrigation user and non users sampled households and their relation to household food security conditions.

To see the food security condition of the irrigation users and non users, household food balance model (HFBM) was used to calculate per capita dietary energy adequacy in kcal against the national standard and then comparison was done between irrigation user and non user households.

Household Food Balance Model, originally adapted by Degefa (1996) from FAO Regional Food Balance Model and thenceforth used by different researchers in this field (Messay, 2010). As the food balance sheet tool has been used by many scientific studies to measure the contribution of

development projects mainly in agriculture sector. Recently, Getinet (2011) also used the model to assess the household food security status of Gubalafto Woreda of North Wollow Zone.

Household Food Balance Model:

NGA = (GP + GB + FA + GG) - (HL+ GU + GS +GV); Where,

NGA = Net grain available/year/household

GP = Total grain produced/year/household

GB = Total grain bought/year/household

FA = Quantity of food aid obtained/year/household

GG = Total grain obtained through gift or remittance/year/household

HL = Post harvest losses/year

GU =Quantity of grain reserved for seed/year/household

GS =Amount of grain sold/year/household

GV =Grain given to others within a year

HFBM was used to assess the household food security status. The steps followed were: Firstly, the period of analysis was fixed as January 1 to December 31, 2013 (year of the study). Secondly, staple food grains in the area are identified. Thirdly, the total HFBM attributes of each stable food grain (GP, GB, FA, GG, HL, GU, GS and GV) were collected in quintal. Thirdly, the net grain balance of each staple grain was computed in kcal using conversion values taken from EHNRI's food composition table for specific food grains used by the sampled households (see Annex 2). Fourthly, total net grain available for consumption at household per annum, per day and household per capita grain availability per day in kcal was calculated. Based on the household per capita grain availability per day in kcal, the household food security status was determined. Accordingly, the households which were found to fall below 2100 kcal, which is the

national minimum recommended calories, were taken as " food insecure households", while those households with kcal above 2100 were taken as" food secure households." Moreover, the household food security stability over the study year was assessed by considering how the household head perceives his /her household food security over the 12 months of the year and household number of meals per day over main seasons of the year. Again the food diversification was measured through collecting the type of food crops and other foods the households used in the year.

To see the contribution of irrigation to household food security, the food crops produced by small scale pump irrigations were listed separately to get net food available at those households and per capita dietary energy contribution from irrigation was calculated. Moreover, the contribution of irrigation to food security through wage generation by users and non users was calculated in terms of the mean income generated and the share used for food item purchase. Furthermore, the direct and indirect contribution of irrigation to household food security through vegetable production was assessed by measuring the frequency of vegetable consumption by households and by calculating the share of income from vegetable selling that was used for food item purchase in the study year

To assess the challenges of small pump irrigation management, the main challenges identified from some secondary documents, from researcher's own experience in working in study area and from inputs of KII were organized in to two categories: technical and institutional, and included in questionnaires against the scale to see the feelings of sampled irrigation user households. Access by farmers to some important training issues was taken as the buffer between the two challenges. The frequencies of the responses of farmers regarding how they felt the challenges were changed in to value multiplying them by the attached scale unit 0, 1, 2 and 3 for none, low,

medium and high respectively. Based on the total value obtained thereof, the challenges were ranked. The ranked challenges were discussed using quantitative and qualitative findings related with the challenges in view of implication on household food security.

CHAPTER FOUR: DESCRIPTION OF STUDY AREA

4.1 Geographic location and topography of Dugda district

4.1.1 Location and Administrative divisions of Dugda district

The research was conducted in three Kebeles (Villages) of Dugda district in East Shewa Zone, in CRVE. East Shewa Zone is one of the 18 zones situated in Oromia Regional Sate in Ethiopia. The capital of the Zone, Adama, is located in CRV about 100 km to the southeast of Addis Ababa, the capital of Ethiopia. CRV of Ethiopia is the area between Yares Fualt in the western edge of Abjata Lake on the southern edge extending to Mieso in the east (Bedru, 2013).

Dugda district is one of the 11 districts of East Shewa zone, where its capital town, Meki, is situated at 134 km south of Addis Ababa. Meki is located at about 88 km from Adama.

The information from Dugda district Agriculture office shows that the district is located between $7^{o}58'$ N and $38^{o}43'$ E. In terms of altitude the district it ranges from 1600 to 2100 meter above sea level. The borders of the district shows: Bora district in the North and North West, Ziway Dugda district in the East, Adam Tullu Jiddo Kombolicha district in the South and Southern Nation Nationalities Peoples of Ethiopia (SNNP) in the west. Administratively, the district is divided in to 36 rural villages and 3 urban units.

4.1.2 The physical and climatic condition of Dugda district

According to the information from the district agriculture office, the soils of the district are fine-textured dominated by sandy, sandy loam and clay loam which makes it suitable for irrigation.

Vegetation is highly dominated by extremely degraded acacia wood land and grass lands. Agro ecologically, the district lies in semi arid zone.

According to the same source, the estimated annual rain fall ranges from 700 mm to 800 mm. The rain condition is usually bimodal; short season starting around mid February to May and the long rainy season from June to mid September. On the other hand the annul minimum and maximum temperature is estimated to be 15^0c and 28^0c respectively.

4.1.3 Population and demographic characteristic s of Dugda district

The data collected from the district Agriculture office shows that, the district has totally a population of 164,394 out of which 84,585 and 78,809 are male and female respectively. In terms of the residential unit 121,321 (62,172 male and 59, 149) are rural while 43,073 (22, 413 male and 20,660 female) are urban. In terms of age distribution 75,472 (45.91 %) belongs to under 15 age, 84,697(51.52 %) of the population belongs to age 15-64 and the remaining 4225 (2.57 %) are above 64 years.

4.2 Socioeconomic conditions of Dugda district

4.2.1 Rural livelihoods options

The rural livelihoods of the district are mainly based on the mixed farming, where crop production and livestock are mainly mixed. These livelihoods are based on the rural land. The total surface area of the district is 95,945 ha. The rural land use pattern of the district shows that 58.27%, 10.33%, 1.47%, 0.12%, 12.54%, 16.97% and 0.3% is farm land, grazing land, forest land, investment land, water bodies, residential, and mountainous and marsh lands respectively

Table 3: Land use pattern of Dugda district

S/N	Type of Land use	Area (ha)	%
1	Farm land	55,907.15	58.27
2	Grazing land	9907.85	10.33
3	Forest land	1411	1.47
4	Investment land	111,083	0.12
5	Water bodies	12,032	12.54
6	Residential	16,278	16.97
7	Mountainous and Marsh land	298	0.3
Total		**95,945**	**100%**

Source: Dugda district agriculture office (2014)

Crop production is one of the most important livelihood options in the district. Crops of various types are produced undertaking both irrigated and rain fed agriculture. The information from the district agriculture office indicated that through rain fed agriculture the district cultivates about 55,000 ha of land while it cultivates about 10,880 ha through irrigation farming. Though the district is practicing rain fed agriculture in such wide scale, it usually constrained by moisture stress due to recurrent drought happens in the area. The main groups of crops produced in the area includes maize, wheat, teff, barley and sorghum from cereals and horse beans, haricot bean, chickpeas and field peas from pulses.

The district is also potential for irrigation from Lake Ziway, Meki River and shallow wells constructed in Lake Ziway wetlands and around Meki River. However, the information from this district agriculture office indicated that few farmers use such opportunity while most of the smallholder farmers rent their land to privates who undertake pump based irrigations in the area. However, the information from Dugda district Irrigation development Authority indicated about 10,004 smallholders are currently using irrigation in the district supported by government,

farmers unions and NGOs. Some of these smallholder farmers were organized in to WUA/ cooperatives. Accordingly, currently there are about 105 WUA/Cooperatives of which 61 become the member of Meki Batu Fruits and Vegetable Growers Union. Through irrigated agriculture the main crops produced include: Onions, tomatoes, peppers, cabbages, papayas, maize and green beans.

In addition to the crop production, the district rural people also undertake livestock rearing. The types of the livestock include: cattle, sheep, goat, donkey, mule, horse and poultry. The detail of the types and corresponding number is indicated in the following table.

Table 4: Livestock types and number in Dugda district

Type of livestock	Total in the district
Ox	39,952
Cow	54,051
Bull	1,676
Hiefer	37,050
Calf	33,036
Sheep	41,101
Goat	43,515
Donkey	17,890
Horse	3,243
Mule	1,248
Poultry	101,611

Source : Dugda district livestock Agency (2014)

4.2.2 Social facilities and services

According to the information obtained from the district Water Resource Development Office, the district existing potable water supply coverage is 74% for rural households and 75% for urban households. The achievement was gained through development of 26 windmills, 45 deep wells, 76 shallow wells, 108 hand pumps and 3540 hand dug wells.

Information from the district health office also indicated that the health office is providing health service to the people of the district through 7 health centers, 36 health posts, 9 drug stores, 4 laboratories and 6 pharmacies.

Regarding education service, the district education office data indicated that there are totally over 34, 000 students (52.62% female and 47.38 males %) attending education in the district. The information from Dugda road authority indicated that the district has about 301.5 km of road net works.

4.3 Over view of the study Villages

The condition of the three study villages is similar to the overall condition of the district. However, they have access to irrigation services. As in the case of other rural areas of the district, the livelihoods of the three villages depend on crop farming and livestock rearing. The crop framing being practiced through both rains fed and irrigated agriculture. Regarding irrigation there are farmers organized in WUA/ cooperative and running their irrigation in the three villages. As can be observed from the following table there are totally 96.75ha of irrigated farm serving 305 households organized in to15 WUA/cooperatives in the three villages.

Table 5: Small scale Pump irrigation development in three study villages

Name of Village	Name of WUA	Beneficiary household number	Irrigation land area(ha)
Wayyo Gabrael	Wayyo Saritte	50	17
	Wayyo Gabrael	48	18
	Bari Dembel	12	3
Abono Gabrael	Oda Bilisa	18	4.25
	Malka Suge	14	3.5
	Chafe Dembel	12	3
	Malka Arara	13	3
	Malka Kombolcha	12	3.5
	Malka Shisa	12	3
Doddota Dembel	Doddota Dembel	15	10
	Garba Dembel	36	9
	Chaleleka Dembel	26	10.25
	Gannet Dembel	12	3
	Dembel Qubsa	13	3.25
	Dembel Batu	12	3
Total	**15**	**305**	**96.75**

Source: Dugda district Irrigation Development Office (2014)

In addition to crop farming through rains fed and irrigated agriculture, the three villages are also undertaking livestock rearing. The detail livestock of the three villages by types and number is indicated by table 6

Table 6: Livestock type and number in three study villages

Type of livestock	Number of livestock by village			
	Wayo Gabrael	**Abono Gabrael**	**Dodota Dembel**	**Total**
Ox	635	857	812	2,304
Cow	935	762	2,529	4,226
Bull	9	6	300	315
Heifer	12	200	2,133	2,345
Calf	639	756	1,001	2,396
Sheep	569	344	1,360	2,273
Goat	263	587	1,945	2,795
Donkey	276	235	352	863
Horse	42	4	20	66
Mule	9	5	6	20
Poultry	1,618	1,541	3,680	6,839

Source: Dugda district livestock Agency (2014)

CHAPTER FIVE: RESULTS AND DISCUSSIONS

5.1 Demographic and Socioeconomic Characteristics of the Sample Households

5.1.1 Sex of household heads and household food security

From the totally sampled 100 households 76 were male headed while the remained 24 were women headed. From the male headed households 38 (50%) were irrigation users while 38 (50%) were non irrigation users. Similarly from female headed households 12(50%) were irrigation users and the remained 12 (50%) were non irrigation users.

From non irrigation user households 18 (47.4%) male and 5 (41.7%) female headed households were food secure while 20 (52.6%) male and 7 (58.3%) female headed households were food insecure. On the other hand from irrigation user households 30 (78.9%) male and 9 (75%) female headed households were food secure while 8 (21.1%) male and 3 (25%) female headed households were food insecure. This descriptive result indicates that in both household types male headed households were more food secure than female headed households. However, the chi-square (X^2= 0.180) test indicates that the relationship is not significant at less than 5% or 10% margin of error.

Table 7: Sex of household head and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Sex of household head	Male	Count	48	28	76
			63.2%	36.8%	100.0%
	Female	Count	14	10	24
			58.3%	41.7%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.2 Marital status of household head and food security

Out of the sampled households 79%, 3%, 2%, and 16% were married, single, divorced and widowed respectively. From 79 married households 40 were irrigation users while 39 non irrigation user households. All the three single headed households were irrigation users. From two divorced one was irrigation user while the other one was non irrigation user household. From 16 widowed households, 6 were irrigation users while 10 were from non irrigation users.

Regarding the food security condition 49(62%), 3(100%), 2(100%) and 8 (50%) households that were managed by married, single, divorced and widowed household heads were food secure respectively. On the other hand 30(38%), 0 (0%), 0 (0%) and 8(50%) households that were managed by married, single, divorced and widowed household heads were food insecure respectively. This does not show clear variation of food security condition with variation in household marital status. The chi square test (X^2= 4.042) does not show significant difference in food security condition among the marital status categories at less than 5% or 10% margin of error.

Table 8: Marital Status of household head and food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Marital Status of household head	Married	Count	49	30	79
			62.0%	38.0%	100.0%
	single	Count	3	0	3
			100.0%	.0%	100.0%
	divorced	Count	2	0	2
			100.0%	.0%	100.0%
	widowed	Count	8	8	16
			50.0%	50.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	38.0%	100.0%

Source: own survey (2014)

5.1.3 Household size and food security

The average household size of the sample households was 6.95 with maximum and minimum size of 3 and 17. This is larger than both national and regional averages which are 4.9 and 5.0 respectively (CSA, 2008). The survey also shows that 36%, 56% and 8% sample households have a family size of under or equal to 5, 6-11,and 12 and above respectively. From 36 households with less than or equal to 5 family members 18 were irrigation users and 18 were non irrigation users. From 56 households with family size of ranging from 6-11, 25 were irrigation users while 31 were non irrigation users. From 8 households with family size greater than 12, 7 were irrigation user while 1 was non irrigation user. There is no difference between irrigation users and non users in terms of family size as they have fifty-fifty percent for both sizes under and above the national average.

As to the food security condition, from households having family size of less than or equal to 5, 75 % and 25% were food secure and food insecure respectively. From the households with 6-11 family size, 58.9 % and 41.1% were food secure and food insecure respectively. From household with family size 12 and above, 25% and 75% were food secure and food insecure respectively. Thus, by percentage values, the food security condition decreases as family size increases and the food insecurity condition increases with increasing family size. The chi-square statistics (X^2 = 7.455) also indicates the relation of food security and family size is significant at less than 5% error.

Table 9: Household size and food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Total household size categorized	<= 5.00	Count	27	9	36
			75.0%	25.0%	100.0%
	6.00 - 11.00	Count	33	23	56
			58.9%	41.1%	100.0%
	12.00+	Count	2	6	8
			25.0%	75.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.4 Age of Household Head and food security

Age data are useful for demographic analysis and for various types of socio-economic development planning. The mean age of the sample household head was 46.72 years with standard deviation of 12.071. The minimum and maximum ages of the household were 20 and 70

respectively. The mean ages of food secure and insecure household are 44.90 and 49.68. Table 10 indicates as age increase food security decreases and food insecurity increases. Getinet (2011) calculated the opposite mean arrangement. However, he indicated that the mean difference was not significant. Similarly, the chi-square statistics (X^2 =4.314) for these categorical data have also insignificant relation at less than 5%.

Table 10: Age of household head and food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Categories of household age	<= 32	Count	8	3	11
			72.7%	27.3%	100.0%
	33 - 45	Count	28	11	39
			71.8%	28.2%	100.0%
	46 - 59	Count	15	13	28
			53.6%	46.4%	100.0%
	60+	Count	11	11	22
			50.0%	50.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.5 Educational level of household head and food security

The study result showed that the sample households head educational levels were 34% illiterate, 10% can read and write while 56 % attended formal education. From 34 illiterates, 13 were irrigation users while 21 were non irrigation users. From 10 household heads that can read and write 4 were irrigation users while 6 were non irrigation users. From 56 household heads who attended formal education, 33 were irrigation users while 23 were non irrigation users.

Generally, from the total who attended formal education, 31 % was below grade 5, 12% grade 6-8, 12 % was grade 9-10 and 1% was above grade 10. The chi-square statistics ($X^2 =$ 4.068) does not show significant relation of irrigation utilization and household head educational level.

Regarding educational level of the household head and food security of the household, the survey showed that from 36 illiterates 16 were food insecure while 18 were food secure. From those 10 households whose heads can read and write, 7 were food insecure and 3 were food secure. From 56 households whose heads attended formal education, 15 were food insecure while 41 were food secure. The chi-square statistics ($X^2 =$8.520) shows significant relation at less than 5% error margin. In contrast to this finding, Getinet (2011) study shows that there is no systematic relationship between educational status of household head and food security status.

Table 11: Education level of household head and food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Education of household head	Illiterate	Count	18	16	34
			52.9%	47.1%	100.0%
	Read and write	Count	3	7	10
			30.0%	70.0%	100.0%
	Formal education	Count	41	15	56
			73.2%	26.8%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.6 Household agricultural labor force and dependency ratio

The nationally accepted labor force is equated with population having age ranging from 15 to 64 years (CSA, 2008). As this age group is expected to participate in productive activities, it affects the food security status of the household. Based on this general consideration the average household labor availability was 3.95 with deviation, minimum and maximum of 2.222,0 and 14 respectively. In this case, the survey result shows that food security status of the household decreases with increasing number of this age group family member. Though there is relation between the number of the age group and household food security, the chi-square statistics ($X2$ = 4.626) shows weak relations of the two variables. It was also assumed that the food security status decreases with increasing dependency ratio where it is defined as the ratio of people aged in between 0 to 14 and above 64 years to those aged from 15 to 64 years. Based on this crude age group analysis, the overall average dependency ratio was 0.90 with standard deviation, minimum and maximum of 0.637, 0 and 3 respectively. The mean dependency ratio for food secure household was 0.83 with standard deviation of 0.55 while that of food insecure household was 1.02 with standard deviation of 0.75. Though the study result showed that dependency ratio of food insecure household was greater than that of food secure household, based on this analysis, dependency ratio has no significant mean difference between the two groups. The lack of strong relation of labor force and dependency ratio to household food security status, in is this case, is due to the fact that all the members of the household who were in the age of 15 to 64 years are not actively involved in the productive activities that have significant influence on the food security. Some of the members in the age group were students while some passed time without work due to lack of employment in this rural area.

Nonetheless, analysis based on only family members in the age of 15 to 64 years and participated in farming activities in the study year showed another picture. The average household labor availability

was 2.76 with standard deviation, minimum and maximum of 1.652, 0 and 6 respectively. Here the overall average household dependency was 1.73 with standard deviation, minimum and maximum of 1.244,0 and 6. In this case food security condition increases and insecurity decreases with increasing actual available labor force. The chi-square statistics (X^2 =5.904) shows significant relations at less than 5% error margin. Moreover, based on this in-depth analysis, food security decreases and insecurity increases with increasing dependency ratio. In this case also chi-square statistics (X^2 =12.747) also shows significant relation at less than 5% error margin.

Table 12: Active farm labor force and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Number of household members of age between 15 and 64 involved in farming last year	<= 2	Count	31	24	55
			56.4%	43.6%	100.0%
	3 - 4	Count	19	13	32
			59.4%	40.6%	100.0%
	5+	Count	12	1	13
			92.3%	7.7%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

Table 13: Real dependency ratio and household food security

			Household food security condition		
			Insecure	**Secure**	**Total**
Household real dependency ratio categorized	<= 0.50	Count	0	11	11
			.0%	100.0%	100.0%
	0.51 - 3.25	Count	28	40	68
			41.2%	58.8%	100.0%
	3.26+	Count	7	2	9
			77.8%	22.2%	100.0%
Total		**Count**	**35**	**53**	**88**
			39.8%	**60.2%**	**100.0%**

Source: own survey (2014)

Regard hiring extra farm labor force, 59% households hired while 41% didn't. From those who hired the labor, 67.8% were irrigation users while, 32.2% were non users. Food secure households hire more labor than food insecure ones. The chi-square statistics (X^2 =9.660) also shows that there is significant relation between extra labor hiring and household food security at less than 5% error.

Table 14: Farm labor hiring and household food security

			Household food security condition		
			Insecure	**Secure**	**Total**
Household farm labor hiring condition	Yes	Count	15	44	59
			25.4%	74.6%	100.0%
	No	Count	23	18	41
			56.1%	43.9%	100.0%
Total		**Count**	**38**	**62**	**100**
			38.0%	**62.0%**	**100.0%**

Source: own survey (2014)

5.1.7 Household farmland size

Greater farm land is assumed to result in better production and hence better household food security. The survey result showed the average farm land holding per household was 2.59 ha which is greater than national average with maximum and minimum holding of 5.00 ha and 0.25 ha respectively. The national average farm land size for household is 0.95 ha (CSA, 1999). Ten sample households, 5 foods insecure and 5 food secure, have farmland holding of less than national average (0.95ha). From these 10 households 9 were non irrigation users while 1 was irrigation user. From 46 households whose holding ranges between 0.96 and 2.97 which was assumed as medium holding in the area, 19 were food insecure and 27 were food secure. In this landholding range 23 were irrigation users while the other 23 were non irrigation users. From 44 households who have holding greater than 2.98 ha which was assumed high holding size in the area, 14 were food insecure and 30 were food secure. Here 18 households were non irrigation users while 26 were irrigation users. There is tendency of farmland expansion in the area as Lake Ziway wetland size shrinks and most of the irrigation users have landholding adjacent to the lake..

Regarding landholding size, there is significant difference between irrigation user households and non irrigation user households. In addition to the landholding analysis between the two categories of households, the chi-square statistics ((X^2 = 7.855) shows significant difference between the two household types in terms of farm land holding at less than 5% statistical error.

As indicated by table 15, food security condition increases, insecurity decreases with increasing farmland holding size. From this descriptive statistics it is evident that farm land holding determines household food security condition. However, the chi-square statistics (X^2 =1.405)

does not show significant relations. In this very drought prone area, availability of water determines more the production from the farmland than the farmland size.

Table 15: Farmland holding and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Total household farmland in ha	<= 0.95	Count	5	5	10
			50.0%	50.0%	100.0%
	0.96 - 2.97	Count	27	19	46
			58.7%	41.3%	100.0%
	2.98+	Count	30	14	44
			68.2%	31.8%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.8 Household livestock number

It was assumed that households with better assets like livestock have better food security condition as they can sell the livestock or its products to access food through purchasing. Moreover, the rural households can utilize the livestock products like milk and meat directly as food. Based on this assumption, the total livestock holding of the sampled households was calculated in Tropical Livestock Unit (TLU) which is equal to 250 kg (see Annex 2). The study result showed the sampled households have on average 4.255 TLU with standard deviation of 2.695. The maximum and minimum holding is 0 TLU and 11.50 TLU respectively. From the total sample households 14 (7 food insecure and 7 food secure) households have less than or equal to 1.50 TLU which was assumed lower holding. From 14 households 5 were non irrigation

users and 9 were irrigation users. On other hands 63 sample households in which 26 were food insecure and 37 were food secure and 41 were non irrigation users and 22 were irrigation users have stock ranging from 1.51 to 6.50 TLU which was assumed medium holding. The remained 23 sample households in which 5 were food insecure and 18 were food secure and 4 were non irrigation users and 19 were irrigation users have livestock above 6.51 TLU which was assumed higher holding. The Pearson chi-square ((X^2 = 16.656) shows significant difference between irrigation user and non user household by livestock holding condition in TLU.

This deference is also clear from differences between average livestock holding in number. On average irrigation user household has 5.75, 1.38, 0.02 and 2.38 cattle including oxen, donkey, house or mule and goat or sheep. The non irrigation users have 4.22, 0.58, 0.04 and 2.72 cattle including oxen, donkey, house or mule and goat or sheep on average. This signifies that fact that irrigation user households have livestock with higher TLU than non irrigation user households. Irrigation user households save the extra income they generate from irrigation farm in the form of higher livestock, as learnt from KII.

Regarding relation of food security and livestock holding condition, as the livestock holding of the household increases the household food security increases and food insecurity decreases (see table 16) However, the chi-square statistics (X^2 =3.723) shows insignificant relation even at 10% margin of error. The livestock selling for food is only the last resort as coping strategy than normal selling for food in the area.

Table 16: Livestock holding and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Total Livestock in TLU	<= 1.50	Count	7	7	14
			50.0%	50.0%	100.0%
	1.51 - 6.50	Count	37	26	63
			58.7%	41.3%	100.0%
	6.51+	Count	18	5	23
			78.3%	21.7%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.9 Household farm draft power, oxen ownership and food security condition

5.1.9.1 Household farm draft power and food security

As in most parts of rural Ethiopia, oxen are used as farming power, the status of household ownership was assumed to influence the household food security condition. The same was assumed for other farm cultivation power utilization like tractor. Accordingly, the research result reveals that only oxen is utilized by 31 (50.8%) food secure and 30(49.2%) food insecure households which indicates totally 61 out of 100 sample households use only oxen for cultivation of farmland. Out of the 61 only oxen user households, 18 were irrigation users and 43 were non irrigation uses. Moreover, from the remained 39 households, 31 (79.5%) food secure and 8 (20.5%) food insecure households utilize both tractor and oxen for their farmland cultivation. From the 39 households that use both tractor and oxen, 32 were irrigation users and 7 were non irrigation users

These analyses indicate irrigation user households use tractors for farm cultivation more than non irrigation user households. The chi- square statistics ((X^2 =26.272) shows significant difference between irrigation users and non users households on cultivation power use at less than 1% error. Moreover, it is clear that households who use improved technologies like tractor for farming were more food secure than those who only use oxen. The chi-square statistics (X^2 =8.298) also confirms significant relation of farmland cultivating powers and household food security condition at less than 5% statistical error.

Table 17: Farmland cultivation power and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household power used for cultivation in last year	Oxen	Count	31	30	61
			50.80%	49.20%	100.00%
	Both tractor and oxen	Count	31	8	39
			79.50%	20.50%	100.00%
Total		**Count**	**62**	**38**	**100**
			62.00%	**38.00%**	**100.00%**

Source: own survey (2014)

5.1.9.2 Household oxen ownership and food security

Regarding, the oxen ownership, from the sample 100 households, 21 had no any ox while 79 owned ox/oxen. Thus the minimum holding was 0 while the maximum was 5 where average holding was 1.60 with standard deviation of 1.137. From the total sample households 41 households out of which 26 were food insecure and 15 were food secure or out of which 27 non irrigation users and 14 irrigation user households have 0 or one oxen. Again from the total sample households 52 households out of which 11 were food insecure and 41 were food secure or out of which 23 non irrigation users and 29 irrigation user households have 2 or 3 oxen. The

remained 7 households out of which 1 were food insecure and 6 were food secure or were all 7 was irrigation user households have 4 or more oxen.

Like the above analysis, the chi- square statistics (X^2 = 11.814) shows significant dereferences between irrigation user and non user households on oxen ownership even at less than 1% statistical error. Similarly, as can be observed from table 18, with increasing oxen holding, household food security is increasing and food insecurity is decreasing. The chi- square statistics (X^2 = 19.18) also shows significant relation between oxen ownership and household food security condition even at less than 1% statistical error.

Table 18: Oxen holding and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Number of oxen owned by household during the survey	<= 1.00	Count	15	26	41
			36.6%	63.4%	100.0%
	2.00 - 3.00	Count	41	11	52
			78.8%	21.2%	100.0%
	4+	Count	6	1	7
			85.7%	14.3%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.10 Household credit access and utilization, and food security

Credit access is believed to improve the production of farming households through purchasing various agricultural inputs and hence improving food security condition. Moreover, household usually takes credit from various sources to purchase foods. From the total 100 sample

households 56 (40 food secure, 16 food insecure) household got access to credit for farming activities. Others 44 did not take any kind of credit during the year. From 56 who took credit, 20 were non irrigation users while 36 were irrigation user households. From 44 household who did not take any credit, 30 were non irrigation user and 14 were irrigation user households. This simple analysis shows irrigation user households tend to take credit for farming than non irrigation user households. The chi square (X^2 = 10.390) shows significant relation between irrigation user and non users in taking credit for farming even at less than 1% statistical error.

From FGD and KII, it was learnt that those households who can purchase agricultural inputs and fulfill food deficit by their own means, those who could not get access to any credit, and those households who fear about the greater interest rate did not take any credit in the year. Both sources also show that irrigation farms need more inputs than non irrigation farms.

Credit sources were two and the purpose for which the credit was taken was diverse. The main was micro finance, where out of 56 households who got credit 48 took credit from the institution and only 8 did not take the service from it. The second source was farmers union where out of the 56 farmers, 19 accessed the credit services from the union and 37 did not take from it. As to the purpose of the credit 43 farmers (77%) took it either for purchasing improved seed or pesticide or fertilizer; 8 farmers (14%) took it for oxen purchase and the remained 5 farmers (9%) took the credit for various purposes including farmland, tractor or oxen renting in.

The research result points out that credit access has significant relation with household food security condition (X^2 = 4.802) at less than 10% error.

Table 19: Farm credit access and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household credit taken for farming in last year	Yes	Count	40	16	56
			71.4%	28.6%	100.0%
	No	Count	22	22	44
			50.0%	50.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.11 Household agricultural inputs utilization and food security

Under this heading, agricultural inputs like improved seed, fertilizer, compost and pesticide utilizations are discussed as they are assumed to increase agricultural production and productivity and thus improve household food security condition.

5.1.11.1 Improved seed utilization and household food security

Regarding improved seed utilization 59 farmer households (44 food secure and 15 food insecure) had utilized it in the study year. Moreover, 41 households (18 food secure and 23 food insecure) did not use the improved seed. From the 59 households who used improved seed in the study year 19 were non irrigation users while 40 were irrigation users. From the 41 households who did not use improved seed, 31 were non irrigation users while 10 were irrigation user households. This signifies that irrigation user households used improved seed more than non irrigation user households. The chi- square statistics (X^2 = 18.231) shows significant difference

between irrigation user and non user households on improved seed utilization even at less than 1% statistical error.

As learned through KII, the main improved seed they used were seeds of maize, wheat and to some extent teff. The study result showed that there is relation of household food security condition and its improved seed utilization. The chi-square statistics(X^2 = 9.660), shows significance relation at less than 1% statistical error.

Table 20: Improved seed utilization and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household improved seed utilization last year	Yes	Count	44	15	59
			74.6%	25.4%	100.0%
	No	Count	18	23	41
			43.9%	56.1%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.11.2 Chemical fertilizer utilization and household food security

The other input considered was chemical (inorganic) fertilizer utilization of the sample households. The average fertilizer utilization was 2.15 quintal with standard deviation of 2.164. The minimum and maximum utilization was 0 and 9.50 quintal respectively. From the total 100 sample households, 22 (5 food secure and 17 food insecure) utilized less than a quarter of quintal; 65 households (19 food insecure and 46 food secure) used 0.26 to 4.88 quintals, and while the remained 13 households (2 food insecure and 11 food secure) used greater than 4.88

quintals of fertilizer. From the 22 households who used less than a quarter of quintal 1 was irrigation user while the other 21 were non irrigation users. From 65 households who used 0.26 to 4.88 quintal 29 were non irrigation users while 34 were irrigation users. Moreover, all the remained households who used more than 4.88 quintals were from irrigation user households. This indicates irrigation user households used more fertilizer than non irrigation households. The chi-square statistics (X^2 = 31.936) also confirms this significant deference at less than 1% error. Moreover, the above analysis and the following table show that chemical fertilizer utilization has relation with household food security condition of the sampled households in the study area. The chi-square statistics (X^2 = 19.346) also confirms this significant relation at less than 1% error.

Table 21: Inorganic fertilizer utilization and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household total fertilizer utilization last year in quintal	<= 0.25	Count	5	17	22
			22.7%	77.3%	100.0%
	0.26 - 4.88	Count	46	19	65
			70	29.2%	100.0%
	4.88+	Count	11	2	13
			84.6%	15.4%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.11.3 Compost or manure utilization and household food security

As to the compost or manure utilization, the average utilization was 8.624 quintals with standard deviation of 14.523. The maximum and minimum utilization were 62 and 0 quintals. From the total sample households 77 households (30 food insecure and 47 food secure) used compost or

manure of less than 10 quintals; 18 households (6 food insecure and 12 food secure) made use of 10 to 36 quintals and the remained 5 households (2 food insecure and 3 food secure) households had used greater than 36 quintals.

From the 77 households that used compost or manure of less than 10 quintal, 44 were non irrigation users while 33 were irrigation users. From 18 households that made use of 10 to 36 quintals, 4 were non irrigation users while 14 were from irrigation users. From the remained 5 households that had used greater than 36 quintals, 2 were non irrigation users but 3 were irrigation users.

This indicates that irrigation users tend to use greater volume of compost or manure than non irrigation user households. The chi-square statistics (X^2 = 7.327) shows significant deference between the two types of household in this input utilization at less than 5% error. The percent comparison shows that food secure households used more compost or manure inputs than food insecure households. However, chi-square statistics (X^2 = 0.250) did not show significant relation between compost or manure utilization of the household and the household food security condition even at less than 10% error. The farmers mentioned that compost preparation and transportation is laborious and does not show immediate result in production out puts.

Table 22: Compost or manure utilization and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household total compost or manure utilization last year in quintal	<= 10.00	Count	47	30	77
			61.0%	39.0%	100.0%
	10.00 - 36.00	Count	12	6	18
			66.7%	33.3%	100.0%
	36.00+	Count	3	2	5
			60.0%	40.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.1.11.4 Pesticide utilization and household food security

The survey reveals that the mean pesticide utilization was 3.649 kg with standard deviation of 5.870. The minimum and maximum utilizations observed among sample households were 0 and 50 kg. From the total samples, 59 households (31 food insecure and 28 food secure) used less than or equal to 2 kg, 40 households (7 food insecure and 33 food secure) utilized between 2 to 26 kg and one food secure household used greater than 26 kg. From 59 households that used less than or equal to 2 kg of pesticide in last year, 49 were non irrigation users while 10 were from irrigation user households. From 40 households that utilized between 2 to 26 kg, 1 was non irrigation user while 39 were irrigation user and one irrigation user used greater than 26 kg. The result shows that irrigation user household used more volume of pesticide than non irrigation user households. The chi-square statistics(X^2 = 62.88) shows significant difference between irrigation user and non user households in pesticide utilization at less than 5% error. Similarly, food secure households have used more pesticide than food insecure households. The chi-square

statistics(X^2 = 13.044) signifies significant relation between utilization of pesticide and household food security status at even less than 1% error.

Table 23: Pesticide utilization and household food security

			Household food security condition		
			Secure	**Insecure**	**Total**
Household total pesticide utilized last year in kg	<= 2.00	Count	28	31	59
			47.5%	52.5%	100.0%
	2.01 - 26.00	Count	33	7	40
			82.5%	17.5%	100.0%
	26.01+	Count	1	0	1
			100.0%	.0%	100.0%
Total		**Count**	**62**	**38**	**100**
			62.0%	**38.0%**	**100.0%**

Source: own survey (2014)

5.2 Food security status of irrigation users and non users in the study area

From totally sampled 100 households, including both irrigation users and non user households, 62 households were found food secure, while 38 were food insecure households. From 62 food-secure households 39 (62.9%) were irrigation users while 23 (37.1) were non irrigation users. Similarly, from 38 food insecure households, 11 (28.9%) were irrigation users while 27 (71.1%) were non irrigation users. This indicates that food security status of irrigation users is better than that of non irrigation users. The chi-square statistics(X^2 = 10.866) implies significant relation between utilization of irrigation and household food security status at even less than 1% error.

Table 24: Food security status of irrigation user and non user households in study area

			Household food security status		
			Secure	**Insecure**	**Total**
Type of household	Non Irrigation users	Count	23	27	50
			37.1%	71.1%	50.0%
	Irrigation users	Count	39	11	50
			62.9%	28.9%	50.0%
Total		**Count**	**62**	**38**	**100**
			100.0%	**100.0%**	**100.0%**

Source: own survey (2014)

The average food availability to food insecure households was 1576 kcal while the average food availability to food secure household was 3164 kcal. This indicates that there is food energy gap to huge proportion of population in the study area.

The average food energy availability to overall households was 2561 kcal, which was more than the national minimum requirement (2100 kcal). The available energy to study households was in the scope of 971 kcal and 8620 kcal which also indicates a great food energy variation among the study households. The case in point is that the average food energy availability to food insecure households is 1576 kcal which falls by 524 kcal (25%) to the national average food energy requirement (2100 kcal).

There is a clear variation between irrigation user households and non irrigation user households in terms of food energy availability. The average kcal available to food insecure irrigation users was 1778 kcal while the average available energy to food insecure non irrigation user households was 1494 kcal. Moreover, the average kcal food energy available to food secure irrigation user households was 3117 kcal while that of non irrigation user households was 2905 kcal.

5.2.1 Household food security stability over the year in the study area

In this study, the food stability is considered to be food security condition of the sampled households over the last year as perceived by the household head.

5.2.1.1 Household food security condition over 12 months of the survey year

Through the study it was found that months such as November, December, January and March has been food secure months for all sampled households in the year 2013 (see table 25). The insecurity condition increases starting from April and reaches pick in August and then the condition becomes improving from September. Non irrigation user households encountered more months of food security than irrigation users. The FGD with both irrigation users and non users also confirmed that such scenario has been in the locality in the normal years.

Table 25: Household food security over 12 months of the year as felt by household head

Months of the year	Household food Security condition (yes= secure, No= insecure)								
	Total households			Irrigation user households			Non irrigation user households		
	yes	No	Total	Yes	No	Total	Yes	No	Total
January	100	0	100	50	0	50	50	0	50
February	100	0	100	50	0	50	50	0	50
March	98	2	100	50	0	50	48	2	50
April	96	4	100	50	0	50	46	4	50
May	90	10	100	48	2	50	42	8	50
June	78	22	100	44	6	50	34	16	50
July	68	32	100	40	10	50	28	22	50
August	63	37	100	37	13	50	26	24	50
September	76	24	100	45	5	50	31	19	50
October	98	2	100	50	0	50	48	2	50
November	100	0	100	50	0	50	50	0	50
December	100	0	100	50	0	50	50	0	50

Source: own survey (2014)

From the sampled 100 households (50 irrigation users and 50 non users) 63 considered themselves as food secure over the year which is almost similar to the finding from assessing household dietary energy availability which showed also 62 households as food secure. The remained 37 households have considered themselves as food insecure. August is the month in which food shortage most happens in the study area. They mentioned multiple reasons as to why their household has been food insecure. From the main reason crop failure due to erratic rain fall during the previous season was mentioned by 28 households. The next reason mentioned by the majority, 18 households, was shortage of oxen. The other grounds mentioned were farm land shortage (8 households), poor farm land fertility (8 households), poor agricultural inputs utilization due to capacity limitation (mentioned by 7 farmers) and lack of proper farm implements (mentioned by one household).

5.2.2.2 Household number of meals per day over the main seasons of the survey year

The survey result indicates that, in terms of number of meals per day, January to March was the best season in the year. In the season, most of the surveyed household could have meals three times while three households could eat four times a day and only one household reported one meal a day. The FGD also confirms that the season is just after harvest and everybody can access food under normal year. July to September is the worst season in the year.

As noted by table 26, the survey result has pointed out that considerable variation between the numbers of meals taken by irrigation user and non user households over the main season of the year. During January to march, from the total 13 households who had less than 3 meals per day, 11 were non irrigation users while only 2 were irrigation users. In April to June, from entire 24 households with less than 3 meals a day, 19 were non irrigation users whereas 5 were irrigation

users. In July to September, from the whole 56 households who had less than 3 meals per day, 34 were from non irrigation users whilst 22 were from irrigation users. Similarly, during October to December, from the overall 18 households with less than 3 meals a day, 14 were non irrigation users and 4 were irrigation users. The FGD and KII also confirmed the same trends. According to the discussants, relatively the food crop production of irrigation users' households is not discontinued by moisture stress unlike non irrigation users. Even when they do not directly produce food crops, the irrigation user households have better capacity to purchase food grain from the market due to selling of vegetable crops produced from irrigable land.

Table 26: Number of meals per day and type of households over main seasons of the year

Season of the year	Type of household	Number of meals per day				
		1 times	2 times	3 times	4 times	Total
	Total household	**1**	**12**	**84**	**3**	**100**
	Irrigation user households	1	1	45	3	50
January to March	Non irrigation user households	0	11	39	0	50
	Total household	**3**	**21**	**76**	**0**	**100**
	Irrigation user households	1	4	45	0	50
April to June	Non irrigation user households	2	17	31	0	50
	Total household	**10**	**46**	**44**	**0**	**100**
	Irrigation user households	3	19	28	0	50
July to September	Non irrigation user households	7	27	16	0	50
	Total household	**3**	**15**	**82**	**0**	**100**
	Irrigation user households	1	3	46	0	50
October to November	Non irrigation user households	2	12	36	0	50

Source: own survey (2014)

5.2.3 Household food diversity and source of grain in the study area

From household food grain availability in terms of dietary energy, it was observed that the main food crops used in the study area were maize (48%), wheat (24%), teff (18%), beans (4%), barley (3%), Sorghum (2%) and Lentils (1%). However, the proportion of the food grain available for consumption varies between irrigation user and non user households. For irrigation users maize (44%), wheat (26%), teff (19%), beans (4%), barley (4%), Sorghum (2%) and Lentils (1%) while for non irrigation users the proportion is maize (54%), wheat (21%), teff (16%), beans (4%), barley (2%), Sorghum (2%) and Lentils (1%). The FGD revealed that teff is considered to be the food of well to do family in the locality.

The main sources of these grains were own production (78.39%), local purchase (21.48%), gift from others /remittance (0.13%) and food aid (0%) in the order of significance .The study year was normal in the study area and there was no emergency food aid during the year.

For food secure households, the proportions of sources were own production (81.47%), local purchase (18.48%), gift from others /remittance (0.05%) and food aid (0%), whereas for food insecure, own production (66.99%), local purchase (32.60%), gift from others /remittance (0.41%) and food aid (0%). This shows that both households directly cover most of their food consumption needs from own production than other means of food source. Nonetheless, it is evident that the food secure households use own production for food consumption source than food insecure households. Similar finding was indicated by Getinet (2011). Conversely, it is clear that the food insecure households used local purchase source for food consumption than that of food secure households. Food remittance is more used by food insecure households than food secure households.

For irrigation user households, the proportion of sources were own production (77.80%), local purchase (21.14%), remittance (0.06%) and food aid (0%), whereas for non irrigation users, own production (79.17%), local purchase (20.61%), gift from others /remittance (0.21%) and food aid (0%). As mentioned during FGD, this small variation may probably due to the fact that irrigation users sell vegetables to purchase food grains.

On the other hand, the survey result showed out of the 100 households 53 (18 non irrigation users and 35 irrigation users) have been consuming milk during the study year. The average milk consumption for the whole sampled households was 0.69 and 1.635 liters per day for non irrigation user and irrigation user households respectively. However, the average milk consumption per day for those who consumed the milk was 1.92 and 2.34 liters for non irrigation user and irrigation user households respectively. Moreover, household consumption frequency of foods like meat and eggs showed (table 27) that all households could not consume the items often but sometimes or on holy days. Most of the households eat such food items only on holy days. There is only slight variation between the consumption frequency of irrigation user and non user households. The frequency for irrigation users is 7 (sometimes) and 43 (only on holydays) while for non irrigation users, the frequency is 1 (sometimes) and 49 (only on holy days).

Table 27: Average household milk consumption per day in liters

Consumption in liters	Frequencies			Total consumed milk in liters		Total
	Non irrigation user households	Irrigation user households	Total	Non irrigation user households	Irrigation user households	
0	32	15	47	0	0	0
0.25	0	1	1	0	0.25	0.25
0.5	0	4	4	0	2	2
1	11	6	17	11	6	17
1.5	1	2	3	1.5	3	4.5
2	2	10	12	4	20	24
3	2	5	7	6	15	21
3.5	0	1	1	0	3.5	3.5
4	1	3	4	4	12	16
6	0	2	2	0	12	12
8	1	1	2	8	8	16
Total	**50**	**50**	**100**	**34.50**	**81.75**	**116.25**
Average				**0.69**	**1.635**	**1.1625**

Source: own survey (2014)

Regarding, the vegetable consumption (see table 28), all households consumes the item either often or sometimes. Irrigation users consume vegetables more often than non irrigation users. From the 43 households which consume vegetables often, 33 were irrigation users while 10 were non irrigation users. From 57 households which consume vegetables sometimes, 17 were irrigation users while 40 were non irrigation users.

Table 28: Frequency of household consumptions of foods like meat and eggs , and Vegetables

Frequency	Consumption of food like meat and eggs			Consumption of vegetable		
	non irrigation user households	**Irrigation user households**	**Total**	**non irrigation user households**	**Irrigation user households**	**Total**
often	0	0	0	10	33	43
sometimes	1	7	8	40	17	57
Only on holydays	49	43	92	0	0	0
Total	**50**	**50**	**100**	**50**	**50**	**100**

Source: own survey (2014)

5.2.4 Coping strategies to food shortages by households

The survey result showed diverse strategies are usually followed by population in the study area to cope with food shortage. The six most important coping mechanisms include; livestock selling (mentioned by 68 households), taking labor in irrigation farm activities (28 households mentioned), borrowing money from different sources (19 households mentioned), taking labor in activities other than irrigation farm related (13 households mentioned), involving in other off farm and nonfarm activities other than labor (mentioned by 13 households) and fuel wood collection and selling (mentioned by 10 households). In this case the most important coping mechanism is livestock sale. In the survey year alone 60 households (28 non irrigation users and 32 irrigation users) sold livestock of any kind generating on average birr 4,346 (3,316 birr by non irrigation user and 5,248 birr by irrigation user households). From the 60 households who sold their livestock 37 (20 non irrigation users and 17 irrigation users) households bought food

from the income generated from livestock sale with average outlay of birr 2341 (1929 birr by non irrigation users and birr 2826 by irrigation user households. This means 58 % of non irrigation households and 54% of irrigation user households bought food from the income they generated from livestock sale.

The other activities mentioned by respondents include sale of local drink (8 households), reducing amount of daily food consumption or number of meals (8 households), borrow cereals from others (4 households), renting in irrigable farm land (3 households), renting out farm lands (2 households), family aid or remittance (2 households), fishing (1 household), monthly salary (1 household. On the other hand 4 households mentioned they did not have a worry to cope with.

In addition to the above mentioned the FGD discussant also raised sowing fast growing and drought resistance food crop varieties, inter-household food or food grain transfer and storing and saving available food grain were mentioned as strategies used by the population in the area.

5.3 Contributions of irrigation to household food security

5.3.1 Contribution of irrigation to food security through enhancing food crops production

In order to determine the contribution of irrigation through enhancing food crops production was through calculating per capita daily contribution in dietary energy expressed in kilocalories. The survey revealed there are 51 farmers having 397 family members who have produced main food crops in the year using irrigation water through full application or supplementary irrigation without considering the production from the same plot of land through rain alone and vegetables produced through irrigation water. The food crops are maize, teff and beans. The total production of each food crop was converted in to dietary energy value in kilocalories. The result obtained thereof was computed to find per capita kilocalories per day which is contribution of irrigation to

household food security through enhancing food crops production. In this case the total dietary energy per capita per day was found to be 746 kcal, which is about 36% the average daily kcal needs of individual per day.

Table 29: Contribution of small scale pump irrigation to household food security though enhancing per capita food energy availability

Type of food grain	Food grain produced through irrigation (Quintal)	Conversion factor (Kcal/Quintal)	Total grain produced through irrigation (in kcal)	Contribution of irrigation to household food security (kcal/person/day)
Maize	244.23	375000	91586250	632
Teff	25.25	358900	9062225	63
Wheat	0	362300	0	0
Barley	0	33900	0	0
Beans	21	351400	7379400	51
Lentils	0	352200	0	0
Sorghum	0	359200	0	0
Total	**290.48**		**108,027,875**	**746**

Source: own survey (2014)

5.3.2 Contribution of irrigation to food security through creating income generating casual employment

The survey revealed that from sampled 100 households 33 (19 from irrigation users and 14 from non irrigation users) were involved in irrigation farm causal labor (see Annex 4). This is when one or more members of the household take part in casual labor in irrigated farm management activities like land preparation, planting of vegetable crops, weeding and cultivating, harvesting and packing of the products. The number of participants in these activities for irrigation household was greater than the number of non irrigation user households. As learned from FGD and KII, this is two reasons. The household members from irrigation user households are more experienced and identify the activities as income generating option and better preferred by

employer farmers than members from non irrigation user households. The second reason is that the irrigation user household members pass more time around irrigated area than members of non irrigated household as the formers have their own irrigation there and their residents are located more proximate to such farms than those of non irrigation user households.

The income generated by irrigation user households from this casual employment was also greater than that of non irrigation user households (see Annex 5). Throughout the year the average income generated by irrigation user households was 5,666 birr while that of the non irrigation households was 3,951 birr. The average income generated by all household was 4,938 birr per household.

To both type of households, the irrigation contributed to household food security through generating income used by household to buy food items From the total 33 households who were involved in irrigation farm casual labor, 30 (18 irrigation users and 12 non irrigation user households) have used the income generated thereof for food purchase. Generally, for all households on average 1,671 birr was used for food purchase. This was 1,713 birr and 1,613 birr for irrigation user and non irrigation user households respectively.

5.3.3 Contribution of irrigation to food security directly and indirectly through production of vegetable crops

The information obtained from Dugda district Agriculture and Irrigation development offices, FGD and KII of the study villages indicate that almost all vegetable production in the district is through irrigation system. Three means of irrigation contributions to household security through vegetable production were found. The first was through directly eating the product as food. Secondly, by means of creating vegetable products that can be accessed by households through

purchase or through their long established social capital. Thirdly, via selling the product and buying food by income generated thereof.

Regarding direct vegetable consummation as food, the survey result shows both irrigation users and non users households have been consuming the product often or sometimes (see table 28 above). For consumption of vegetable products by households three main sources: directly from own production, purchasing and getting from other neighbor farmers through their long established social capital or as incentive to daily laborers were identified (see table 30). From 100 sampled households, 29 households (5 irrigation users and 24 non irrigation users) accessed only through purchase, while one household from irrigation users accessed only through own production. The FGD and KII revealed that the presence of irrigation farms in the study area have made possible for population to easily get access to purchase vegetable food items in reasonable price. There was no any household who depended only on gift from others. Again 15 households (14 irrigation users and 1 non irrigation users) depended on both purchase and own production. In this case one household from non irrigation user has produced from shared in or rented in irrigable land. Major means of access was purchase and gift from others combined where total 31(7 irrigation users and 24 non irrigation users) obtained the food item. From the total, 24 (23 irrigation users and 1 non irrigation user) used the three means to acquire the food product.

Table 30: Household vegetable source for consumption as food

Sources	Non irrigation user households	Irrigation user households	Total
Purchased	24	5	29
Own production	0	1	1
Purchased, own production and gift from others	1	23	24
Purchased and gift from others	24	7	31
Purchased and own production	1	14	15
Total	**50**	**50**	**100**

Source: own survey (2014)

Moreover, the survey has discovered that irrigation user households sell vegetable crop and buy locally consumable food grains or other food items. In the survey year 2 non irrigation households (through renting in or shared in irrigable land) and 35 irrigation user households produced and sold the vegetable or fruit products from irrigation farming system. On average each non irrigation user and irrigation user households could generate birr 12,250 and 14, 597 respectively. From the total 37 households who have generated this income, 25 (1 non irrigation users and 24 irrigation users) used the income for food purchase. On average the non irrigation user households used birr 1200 while irrigation user households used birr 3,327.

5.4 Challenges of Small Scale pump irrigation that affect household food security

5.4.1 Introduction

In development endeavor, it is natural to encounter challenges. To be effective in managing any venture, these challenges should be addressed properly. In order to analyze the challenges related

to small scale pump irrigation, two broad issues: institutional and technical challenges were addressed where capacity building is at the buffer zone of the two.

Technical challenges are concerned with constraints related to gaps in technical knowledge and skill of the irrigation user farmers, the inherent problems of the quality of inputs and biophysical environment of small scale pump irrigation schemes. The institutional challenges are gaps and setbacks posed by non functionality of rules and regulations governing access, rights, claims, services; institutional capabilities and opportunities to effectively use small scale pump irrigation schemes.

5.4.2 Challenges in the area of important trainings in small scale pump irrigation management

The study result showed that most of the irrigation users took trainings that technically equip them to run their irrigation farm. The training gaps observed were in the areas of pump operation and marketing.

The focus group and key informant mentioned that RCWDO provided trainings in the study year and the government also arranged general orientation on wide array of rural development activities which also included these training topics to some extent in the form of campaign. It was also learnt from the FGD that though the trainings were delivered in the year in general terms, there is considerable knowledge and skill gaps in the area of vegetable crops pest management, pump operation and maintenance, water and soil quality management. Table 31 presents the detail training issues and the number and percentage of farmers that attended the training in the study year

Table 31: Training issues and number and percentage of farmers attended

Training issues	Have you ever received training on the following issues in the last year?					
	Yes		No		Total	
	N	%	N	%	N	%
WUA/cooperative management	40	80	10	20	50	100
Soil fertility management	46	92	4	8	50	100
Irrigation water management	38	76	12	24	50	100
Bed preparation and vegetable nursery management	38	76	12	24	50	100
Planting of vegetable seedlings	39	78	11	22	50	100
Weeding and pest management	40	80	10	20	50	100
Proper Inputs selection & their application	44	88	6	12	50	100
Crop harvesting& post harvest management	40	80	10	20	50	100
Pump operation and management	21	42	29	58	50	100
Inputs and outputs marketing	31	62	19	38	50	100

Source: own survey (2014)

5.4.3 Technical challenges of small scale pump irrigation scheme management.

Based on the extent of feeling of the farmers, the technical challenges of small scale pump irrigation in the study area are ranked in the following order from higher severity to lower severity (see table 32) and discussed by qualitative findings from FGD and KII:

1. **Poor inputs quality:** This is the most important technical challenge of irrigation users as it determines the yield, productivity and quality of the production. The quality of vegetable seeds and pesticide was mentioned as serious problems by farmers. Low germination of seeds, seeds happening to be unwanted variety after germination and inefficacy of pesticides are some of the features of the challenge. Over utilization of

seeds and pesticides has been the consequence. Thus, the challenge is leading to either crop failure or high cost or both and hence has impact on food security condition of the irrigation users.

2. **Crops disease:** The area has been under vegetable production for long period of time and many types of crops disease especially that of vegetable has been happening. The farmers have limited skill in identifying the type, and necessary management and control mechanisms for the disease. This has led to frequent vegetable crops failure particularly on tomato and onion which further leads to low production, low income, low means to purchase food.
3. **Limited skill in pump maintenance:** The types of the irrigation pumps are not well known by the farmers. They have limited skill on operation and maintenance of small scale pumps. Thus, for simple breakage that can easily be adjusted, sometimes crops failure occurred in the study area.
4. **Frequent pump failure:** Either due to the limited skill of the operators or limited knowledge of the nature of the pump, usually there has been frequent pump failure which leads to crop failure
5. **Salinity:** The farmers are reporting increasing salinity in the irrigated farm land. The researcher also observed soil color change in to black and wilted pepper in some farms in Abono Gabrael Village. The farmers mentioned that was due to the salinity of the soil. This needs further investigation**.** According to the focus group discussion, farmers who use water from shallow well are more affected by salinity than those who use water from the adjacent Lake: Lake Ziway. Smallholders usually have no capacity to purchase pump and start the irrigation. NGOs like RCWDO do not promote utilization of water

from the lake and organize farmers on shallow well irrigations. Lake water is more used by investors or elite farmers and irrigation land grabbers than by smallholder farmers. Some farmers are forced to rent out irrigable land to these bodies due to capacity to afford the cost related with irrigation agriculture. District irrigation development office estimates the cost of producing onion and tomato from a hectare of land as ETB 21,570 and 28,600 respectively. The discussion with farmers disclosed that though the local smallholder farmers are not using the lake water, actually the lake water is not saved as whished by some local NGOs working in the area.

6. **Poor farm land quality:** Though many literatures assume that the soil of the area as good for irrigation farming, some farmers mentioned their farms as poor quality due to the development of salinity, gradual loose of fertility because of intensive farming and the sandy nature of soils which leads to water over utilization.
7. **Poor irrigation infrastructure:** The irrigation infrastructure determines irrigation water efficiency. Where canals exist like in the case of Wayyo Gabrael , there is canal cracking which led to water loss, where there is no canal there is high water loss before reaching actual crop field. The farmers are currently using plastic hose to convey water to increase water use efficiency. In the case of shallow wells, the pumps are put in the gallery of about 10m to 17m in order to pump the water. But, pump overheating, pump holes filled by smoke that makes pump operation difficult for farmers and unsuitability to go down in to the gallery and operate the pump were the challenges observed and mentioned by the farmers**.**

8. **Vegetable crops short shelf time:** Most of the time, the farmers produce vegetables like onion and tomato which are naturally perishable. There is no proper skill and facility to increase the shelf time of the crop before selling which is leading to great loss
9. **Limited skill in pump operation:** Limited training of farmers was found as one of the sources of this challenge.
10. **Irrigation water shortage:** There are two irrigation water sources for sample irrigation user households. The study showed that 30 of the 50 sample households use water from lake, 14 households use water from shallow well and 6 of them use both lake and shallow well. The lake water shortage happens due to lake receding back during dry season while shallow well water also dries during dry season. There are many shallow wells operating in the area proximate to each other which compute for ground water during dry season.
11. **Limited knowledge and skill in crops agronomy**: The farmers feel that they have good skill on vegetable crops agronomic practices in the area of land preparation, nursery and field crop management. However, it was learnt during the FGD that there is limitations in the area of crop protection and post harvest management.

Table 32: Extent of technical challenges felt by irrigation user households

Type of technical challenges	Extent of the challenges as felt by the household head (frequencies)										Extent of the challenges as felt by the household head (value)					
	None		Low		Medium		High		Total		None	Low	Medium	High	Total	Rank
	N	%	N	%	N	%	N	%	N	%						
Poor land quality	1	2	5	10	38	76	6	12	50	100	0	5	76	18	99	6
Irrigation water shortage	6	12	15	30	24	48	5	10	50	100	0	15	48	15	78	10
Poor inputs quality	0	0	1	2	11	22	38	76	50	100	0	1	22	114	137	1
Poor irrigation infrastructure	0	0	12	24	29	58	9	18	50	100	0	12	58	27	97	7
Frequent pump failure	0	0	2	4	22	44	26	52	50	100	0	2	44	78	124	4
Limited knowledge and skill in agronomy	9	18	30	60	7	14	4	8	50	100	0	30	14	12	56	11
Limited skill in pump operations	4	8	18	36	23	46	5	10	50	100	0	18	46	15	79	9
Limited skill of pump maintenance	1	2	1	2	18	36	30	60	50	100	0	1	36	90	127	3
Salinity	4	8	5	10	25	50	16	32	50	100	0	5	50	48	103	5
Crops disease	0	0	3	6	13	26	34	68	50	100	0	3	26	102	131	2
Vegetable crops short shelf time	1	2	16	34	25	53	5	11	47	100	0	16	50	15	81	8

Source: own survey (2014)

5.4.4 Institutional challenges of small scale pump irrigation scheme

The research result showed that the institutional challenges are also the causes for most of the training gaps and technical challenges felt by irrigation user households. The institutional challenges were ranked as follows from highest to lowest challenge in terms of severity to the

farmers' production process (see table 33) and discussed by quantitative findings from household survey and qualitative findings from FGD and KII:

1. **Inputs and output marketing:** The irrigation users get different agricultural inputs from diverse sources. Vegetable seeds are accessed from local agricultural vendor shops, Meki Batu Fruits and vegetables Growers union, from own seed production and purchasing from other fellow farmers. The challenges felt include affordability, lack of quality seed: full of impurity, low germination rate, becoming unwanted variety; and unavailability in terms of type and adequacy. In terms of seed quality, the farmers prefer their own or fellow farmers' source and seeds from union to local shops. Pesticides are accessed from either union or local shops. Affordability, quality and efficacy were the main challenges felt by the framers. Irrigation pumps are supplied from Addis Ababa and affordability and quality are the challenges related. The sample households use pumps supplied by government and NGOs. Fertilizer and cereal crops seeds are mostly supplied through multipurpose unions. Affordability and unavailability were the challenges felt by farmers. There were farmers using the maize seed repeatedly more than technically recommended due to capacity to purchase the seed each year. According to Dugda district Agriculture office KII, the back source of seeds of cereals is usually authorized seed enterprises while there is no genuine vegetable seed source in the country.

   The farmers also felt challenges on outputs marketing mainly perishable vegetable crops. The farmers produce mostly what the land can produce, not based on sound market demand. Even though some amount of this produce can be sold in local market, the main market channel is Addis Ababa. Unpredictability of the price, brokers' fraudulences and limited power of farmers associations like cooperatives/union to influence the market are

the main challenges. The challenges are intensified by lack of agro processing means and storage facilities for the main vegetable crops produced in the area: tomato and onion**.**

2. **Getting pump maintenance services:** The farmers get maintenance service in most cases from inexperienced local technicians. Their services are also felt as very costly. In rear cases, they get such services from NGOs. There is no a well established intuition or genuine workshop which gives such services. The district has no capacity in terms of human and financial resources to provide the service. The other challenges were unavailability and affordability of spare parts for maintenance.
3. **Water users Association governance:** Out of the 50 sample irrigation user households' heads who are members of water users association or cooperative, 26 farmers (52%) take the institutions as weak while the remained 24 farmers (48%) considered them as strong. Most feel that their committee members are not transparent, not accountable and also corrupt. The other challenge attached with water users' association governance is that there is limited power in the area of marketing of agricultural produces and purchasing effectively agricultural inputs and services like pump maintenance. Almost all sample water users associations have no significant saving to purchase or rent in other pumps or get maintenance services timely when the existing pump breaks. They usually collect money from the members after the breakage happens which leads to crops failure. From 50 farmers, 20 encountered incident of crop failure last year out of which 14 reported that it was due to pump breakage.
4. **Accessing adequate credit:** The main source of the agricultural credit is union and microfinance for the sample households. Unavailability, high interest rate and inadequacy of the credit were mentioned as the main challenges.

5. **Accessing extension service:** This is highly connected to limited government support. The extension service in the area focused more in rain fed agriculture. There is no irrigation development agent assigned at village level.
6. **Absence or limited government support:** Irrigation users expect government support mainly in the area of technical capacity building and creating enabling environment for getting inputs and outputs marketing**.** They felt that such services are not up to the mark.
7. **Labor shortage:** The wedge rate of the labor is increasing. Availability is also poor in the market during intensive work like planting, weeding and harvesting. Some households are labor poor. Some households who potentially labor rich are becoming as some of their family members who are in working age group are students.
8. **Irrigation land adequacy:** The average irrigation land owned by the irrigation users is 0.54 ha which is above the legally allowed 0.50 ha in Ethiopia. Out of the sample 50 irrigation user households, 13 owned 0.25ha, 21 owned 0.50ha, 11 owned 0.75ha and 5 owned 1ha. They farmers equate irrigation land adequacy with their labor availability and capacity to afford related agricultural inputs. Farmers who currently owned only small ploys and capacity in terms of labor source and financial resources demand higher irrigation land size. Some fulfill the demand through renting in more irrigable land from those farmers with low capacity.
9. **Conflict in irrigation water utilization:** The conflict in irrigation water users occurs because of shallow wells which are proximate to each other and computing for water. There were also conflicts in water use scheduling.

Table 33: Extent of institutional challenges as felt by irrigation users

Type of technical challenges	Extent of the challenges as felt by the household head (frequencies)										Extent of the challenges as felt by the household head (value)					
	None		Low		Medium		High		Total							
	N	%	N	%	N	%	N	%	N	%	None	Low	Medium	High	Total	Rank
Irrigation land adequacy	22	44	10	20	14	28	4	8	50	100	0	10	28	12	50	8
Water users Association governance	4	8	6	12	23	46	17	34	50	100	0	6	46	51	103	3
Accessing adequate credit/ finance	5	10	12	24	12	24	21	42	50	100	0	12	24	63	99	4
Accessing extension services	0	0	15	30	28	56	7	14	50	100	0	15	56	21	92	5
Input and outputs marketing	0	0	1	2	4	8	45	90	50	100	0	1	8	135	144	1
Getting Pump maintenance services	0	0	1	2	7	14	42	84	50	100	0	1	14	126	141	2
Conflict in water utilization	9	18	34	68	7	14	0	0	50	100	0	34	14	0	48	9
Labour shortage	5	10	33	66	10	20	2	4	50	100	0	33	20	6	59	7
Absence or limited government support	0	0	30	60	16	32	4	8	50	100	0	30	32	12	74	6

Source: own survey (2014)

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The research was conducted in CRVE where household food shortage usually happens in the country and investment in irrigation is being done to tackle the problem. The study was aimed at understanding the contributions of small scale irrigation to household food security. Three villages: Wayyo Gabrael, Abono Gabrael and Doddota Dembel were taken as study area and 2013 as study year.

The finding on characteristics of demographic and socioeconomics of sampled households revealed that 76% was male and 24% was female headed households. Moreover, 79%, 3%, 2%, and 16% household heads were married, single, divorced and widowed respectively. The average household size (6.95) was found larger than both national and regional averages which are 4.9 and 5.0 respectively according to national census 2007. The mean age of the sample household heads was 46.72 years with standard deviation of 12.071 years. The households head educational levels were 34% illiterate, 10% can read and write while 56 % attended formal education.

It is evident from the result that male headed households are more food secure than female headed households. No food security difference due to household head marital status. The household food insecurity condition increases with increasing family size. There is insignificant relation between age of household head and household food security. Educated households are more food secure than uneducated households.

As to the available farm labor force and dependency ratio, taking family members of age 15 to 64 years as farm labor force, the average household labor availability was 3.95 with standard deviation, minimum and maximum of 2.222, 0 and 14 respectively. Based on this crude age

group analysis, the overall average dependency ratio was 0.90 with standard deviation, minimum and maximum of 0.637, 0 and 3 respectively. However, all farm labor was not participated in farm activities as some were students and some passed without employment. Taking the labor force group who were involved in the farm activities, the average household labor availability was 2.76 with standard deviation, minimum and maximum of 1.652, 0 and 6 respectively. Here the overall average household dependency ratio was 1.73 with standard deviation, minimum and maximum of 1.244,0 and 6. Food security condition increases and insecurity decreases with increasing actual available labor force. Food security decreases and insecurity increases with increasing dependency ratio. Regarding hiring the labor force, 59% sampled households hired extra labor force while 41% didn't. Food secure and irrigation user households hire more labor than food insecure and non irrigation user households. This indicates that irrigation creates rural employment that contributes to food security.

Concerning household assets holding, the average farm land holding per household was 2.59 ha which is greater than national average with maximum and minimum holding of 5.00 ha and 0.25 ha respectively. The national average farm land size for household is 0.95 ha (CSA, 1999). The average household livestock holding was 4.255 TLU with standard deviation of 2.695TLU. The maximum and minimum holding is 0 TLU and 11.50 TLU respectively. Regarding oxen ownership, 21% had no any ox while 79% owned ox/oxen. Thus the minimum holding was 0 while the maximum was 5 where average holding was 1.60 with standard deviation of 1.137. Irrigation user and food secure households have more farmland than non irrigation user and food insecure households. However, the relation between farmland size and food security is insignificant as in drought prone area of CRVE availability of water determines more the production from the farmland than the farmland size. Irrigation users have more livestock in

TLU unit than non irrigation users. As the livestock holding increases the household food security increases. Irrigation user households have more oxen than non irrigation households. With increasing oxen holding, household food security is increasing. This shows that irrigation contributes to improvement in household assets that further improvement in household food security.

Regarding farm inputs utilization, in terms of farm draft power, 61% households used only oxen while 39% used both oxen and tractor. Furthermore, 56% households took credit from either union or microfinance while 44% didn't. Moreover, 59% households had utilized improved cereal seeds while 41% didn't. The average household fertilizer utilization was 2.15 quintals with standard deviation of minimum and maximum utilization of 2.164, 0 and 9.50 quintal respectively. The average household compost or manure utilization was 8.624 quintals with standard deviation of 14.523. The mean household pesticide utilization was 3.649 kg with standard deviation of 5.870. The minimum and maximum pesticide utilizations observed among sample households were 0 and 50 kg. Irrigation user households use tractors for farm cultivation more than non irrigation user households do. Households who use improved technologies like tractor for farming were more food secure than those who only use oxen. Irrigation user and food secure households tend to take credit for farming than non irrigation user and food insecure households. Irrigation user and food secure households use improved seed more than non irrigation user and food insecure households. Irrigation users and food secure households also use more volume of fertilizer, compost or manure and pesticide than non irrigation user and food insecure households. This indicates that irrigation helps the smallholder farmers to use improved technologies that help them to boost their production and ensure food security.

Generally the study disclosed that using irrigation agriculture enhances household food security not only through providing water to farm during dry season for enhancing agricultural production but it also creates rural employment, household assets and utilization of improved farm technologies that also enhance agricultural production.

In the study area 62% of the populations were found food secure, while 38% were food insecure. From food secure households 62.9% were irrigation users while 37.1% were non irrigation users. The average annual food availability to overall households was 2561 kcal, which is more than the national minimum requirement (2100 kcal). However, the average food availability to food insecure households is 1576 kcal which falls by 524 kcal (25%) to the national average food energy requirement. The average food availability to food secure households was 3164 kcal. This indicates that there is food energy gap to huge proportion of population in the study area. The average kcal available to food insecure irrigation users was 1778 kcal while the average available energy to food insecure non irrigation user households was 1494 kcal. Moreover, the average kcal food energy available to food secure irrigation user households was 3117 kcal while that of non irrigation user households was 2905 kcal. Thus, irrigation user households have better annual food availability status than non irrigation user households. This signifies that small scale pump irrigation plays a key role in improving a growing demand for food and to achieve long term food security goals.

In the study area and study year November, December, January and March has been food secure months. The insecurity condition become intense starting from April and reaches pick in August and then the condition becomes improving from September on ward. In terms of number of meals per day, January to March was the best and July to September was the worst season in the year. Non irrigation user households encountered more months of food insecurity (8) than

irrigation users (5). Irrigation users are better than non irrigation users in having more number of meals per day over the season of the year. These indicate that small scale irrigation tends to stabilize the food security condition over time.

The main food crops used in the study area were maize (48%), wheat (24%), teff (18%), beans (4%), barley (3%), Sorghum (2%) and Lentils (1%). The main sources of these grains were own production (78.39%), local purchase (21.48%), gift from others /remittance (0.13%) and food aid (0%) in the order of significance. The average milk consumption for the whole sampled households was 0.69 and 1.635 liters per day for non irrigation user and irrigation user households respectively. Food like meat and egg were eaten mostly on holydays while vegetables were eaten often or sometimes. Vegetable sources were from own production, purchase and through gift. The three most important coping strategies in the area are livestock selling, taking labor in irrigation farm activities and borrow money from different sources. Irrigation users diversify their food than non irrigation households. This signifies that irrigation plays profound role in diversifying household food consumption.

In addition to enhancing household asset and facilitating more use of agricultural technologies, irrigation also contributes to household food security through other three ways. These are through directly enhancing the production of food grains, through using vegetables produced from irrigation farm directly as food and through purchasing food items by incomes generated from production of cash crops like vegetables and fruits. These indicate that small scale irrigation contributes to household food security in multifaceted ways.

Though, the small scale pump irrigations have such diverse contributions to household food security there are also challenges which should be addressed by development actors. These are

challenges related to trainings, technical challenges and institutional challenges. There is considerable knowledge and skill gaps among irrigation users in the area of vegetable crops pest management, pump operation and maintenance, water and soil quality management.

The technical challenges of small scale pump irrigation in the study area ranked from higher to lower are poor agricultural inputs quality, crops disease, limited skill in pump operation and maintenance, frequent pump failure, developing soil salinity, poor farmland quality, poor irrigation infrastructure, short vegetable shelf time, limited skill in pump operation, irrigation water shortage and limited knowledge and skill in crops agronomy.

The institutional challenges ranked in the same order include: inputs and output marketing, getting pump maintenance services, Water users Association governance, accessing adequate credit, accessing extension service, absence or limited government support, labor shortage, irrigation land adequacy and conflict in irrigation water utilization. These diverse challenges indicate that there are a huge gap to efficiently and effectively make use of small scale irrigation for enhancing household food security and rural livelihoods.

6.2 Recommendations

Based on the findings and discussions made and conclusions reached, under this study, the following recommendations are forwarded:

1. The capacity of smallholders technically and in leadership and management is highly imperative for smallholder effective irrigation management and utilization. The study shows gaps related to such areas. It is therefore very important to provide capacity building training for farmers especially in the areas of vegetable crops pest management,

pump operation and maintenance, water and soil quality management and leadership and management of the institutions.

2. Unlike the seeds of cereal crops, finding quality and genuine vegetable seed is a serious problem that affects the production from irrigation farms. Thus, it is valuable to have responsible institution in government framework that administers vegetable seeds.
3. There are many shallow wells based irrigation schemes in the Lake Ziway catchment that compute for ground water. Shallow well users are more affected by salinity than those irrigators who use lake water. Lake water is more used by investors, elite farmers and irrigation land grabbers than local poor smallholder farmers. Some farmers rent out their irrigation land due to limited capacity to afford costs related to irrigated agriculture .Thus; there is a need for further study to design environmentally feasible strategy that makes the local smallholders to use the water and land resource of the area.
4. It was reported that irrigation land has been losing fertility and developing salinity due to intensive farming and utilization of especially ground water. Irrigation landholding was greater than the legally recommended size. However, some farmers wanted to have more land. Therefore, there is a need to promote soil augmenting technologies like compost based on soil testing.
5. Input and output marketing was reported to be one of the factors which discouraged farmers from practicing in irrigation farming chiefly perishable vegetable crops. Thus, there is a need to have a strategy that gives all market actors a space to influence the market benefits and to build the capacity of WAUs/ cooperatives and to diversify products.

6. Irrigation infrastructure in the area was reported to have diverse challenges in their design and maintenance. Thus designing environmentally and socially suitable infrastructure and developing sustainable mechanism of maintenance is profoundly important.
7. Getting irrigation pump maintenance service is one of the problems that hinder the effectiveness and efficiency of irrigation schemes in the area. Establishment and strengthening of responsible institution is highly required.
8. Perishable vegetable products are highly produced in the study area. Thus, there is a need to have agro processing technologies and cooled storage systems in the area.
9. The existing extension service is more rain fed agriculture focused. There is a need to put both irrigated and rain fed agricultural extension systems on the same footing to ensure household food security.
10. Households with more oxen and other livestock holding are more likely to be food secure. Especially, oxen are the main draft power in the study area. Thus it is essential to have a strategy that focuses on supporting poor smallholder farmers through credit to purchase oxen and overall livestock management in such rural area to ensure smallholder household food security.

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APPENDICES

Annex 1: Type of food grain and food energy

Type of food grain	Food energy (Kcal/Quintal)
Maize	375000
Teff	358900
Wheat	362300
Barley	33900
Beans	351400
Lentils	352200
Sorghum	359200

Source: adapted from EHRI food composition table by researcher

Annex 2: Total livestock unit conversion factor

Livestock	Average Biomass (Kg)	TLU Equivalent
Camels	250	1
Cattle	175	0.7
Sheep/Goat	25	0.1
Horses/Mules	200	0.8
Donkeys	125	0.5

Source: Source: Storck, et al. (1991) in Getinet (2011)

Annex 3: Dietary energy availability of sampled households in kcal/ person / day by type of households

Food security status	Household type	Code of household head	GP	GB	FA	GG	Sub total	HL	GU	GS	GV	Sub total	NGA
Food Secure households	Irrigation users food Secure households	1	3,361	911	-	-	4,273	-	132	1,644	-	1,776	2,497
		2	3,181	1,071	-	61	4,313	-	456	1,534	-	1,990	2,324
		4	3,447	350	-	-	3,798	-	377	418	-	795	3,002
		5	3,431	1,184	-	-	4,615	-	644	-	93	737	3,878
		6	3,300	1,858	-	-	5,158	-	433	186	235	854	4,304
		7	1,795	1,322	-	-	3,117	-	34	96	-	130	2,987
		8	2,773	901	-	-	3,674	-	195	221	55	470	3,204
		9	2,671	1,495	-	-	4,165	-	149	1,182	-	1,331	2,834
		10	2,376	1,872	-	-	4,248	-	127	1,284	-	1,411	2,837
		20	3,978	508	-	-	4,486	-	198	1,538	-	1,736	2,750
		22	6,750	1,042	-	-	7,792	-	-	5,137	-	5,137	2,655
		24	1,883	708	-	-	2,591	-	87	385	-	472	2,119
		26	5,411	624	-	-	6,035	-	358	1,814	-	2,173	3,863
		27	3,293	112	-	-	3,406	-	589	155	-	744	2,662
		28	2,194	356	-	-	2,550	15	269	93	26	403	2,147
		29	5,078	48	-	-	5,126	-	129	1,126	-	1,255	3,871
		30	2,176	1,061	-	-	3,237	-	125	669	-	794	2,442
		31	6,586	739	-	-	7,324	-	83	2,139	-	2,222	5,103
		41	3,469	813	-	-	4,283	-	396	827	-	1,224	3,059
		42	2,506	1,603	-	-	4,109	-	174	295	119	587	3,522
		43	2,376	1,840	-	-	4,216	-	127	1,284	-	1,411	2,805
		44	2,602	1,507	-	37	4,146	41	223	197	119	579	3,567
		45	7,922	172	-	-	8,094	-	247	1,027	-	1,274	6,820
		46											

			7,976	80	-	-	8,056	-	816	3,487	-	4,303	3,753
		47	5,753	-	-	-	5,753	93	562	2,108	280	3,043	2,710
		50	3,565	2,670	-	-	6,234	-	574	1,191	-	1,765	4,469
		51	3,791	1,030	-	-	4,821	-	331	989	331	1,651	3,170
		52	3,961	1,341	-	-	5,302	-	494	1,985	-	2,480	2,823
		71	5,212	1,141	-	-	6,354	-	358	1,814	-	2,173	4,181
		72	4,641	829	-	-	5,470	-	276	827	-	1,103	4,368
		73	6,898	739	-	-	7,637	-	152	2,025	27	2,204	5,433
		74	2,971	1,384	-	-	4,355	-	204	1,220	26	1,450	2,905
		75	2,997	928	-	-	3,925	17	167	221	88	493	3,432
		82	2,452	1,910	-	-	4,362	-	129	2,055	-	2,183	2,179
		83	6,379	1,153	-	-	7,532	-	128	4,880	-	5,008	2,524
		85	3,567	1,108	-	-	4,675	-	112	1,644	-	1,756	2,919
		87	2,005	791	-	-	2,796	-	195	110	77	382	2,414
		88	3,962	2,190	-	-	6,151	-	561	1,468	37	2,065	4,086
		89	2,176	1,226	-	41	3,443	21	125	503	49	698	2,744
	Non irrigation users food Secure households	13	3,484	571	-	-	4,055	-	216	1,543	-	1,759	2,297
		14	2,601	147	-	-	2,748	-	-	581	-	581	2,167
		15	5,402	-	-	-	5,402	-	257	3,031	-	3,289	2,114
		18	5,332	1,087	-	-	6,419	-	557	1,553	631	2,741	3,678
		33	4,394	700	-	-	5,094	-	673	662	335	1,670	3,424
		34	2,742	847	-	-	3,589	-	520	-	220	740	2,849
		35	2,853	2,348	-	-	5,201	-	221	199	-	419	4,782
		37	4,368	910	-	-	5,277	-	466	1,156	-	1,623	3,655
		40	3,466	182	-	-	3,648	-	297	823	66	1,186	2,462
		53	4,571	685	-	-	5,256	-	305	1,148	64	1,517	3,739
		54	3,951	1,177	-	-	5,128	-	81	1,299	584	1,964	3,164
		62											

			10,793	509	-	-	11,302	-	442	8,073	-	8,515	2,787
		64	3,328	867	-	-	4,195	-	41	990	-	1,031	3,164
		66	5,159	-	-	-	5,159	-	103	2,277	-	2,380	2,779
		68	2,345	1,358	-	-	3,703	-	370	823	-	1,193	2,510
		77	2,891	287	-	-	3,179	-	71	869	-	940	2,238
		80	1,761	688	-	-	2,449	-	-	-	-	-	2,449
		90	1,605	755	-	-	2,360	-	206	-	-	206	2,153
		92	5,749	82	-	-	5,831	-	185	2,359	-	2,544	3,287
		94	4,329	380	-	-	4,709	75	106	990	-	1,172	3,538
		96	11,076	69	-	-	11,145	-	461	7,790	-	8,251	2,894
		98	1,647	789	-	26	2,462	-	247	-	-	247	2,214
		100	1,674	831	-	-	2,505	-	43	-	-	43	2,463
Food Insecure Households	**Irrigation users food Insecure households**	3	1192	181	0	0	1373	0	0	0	0	0	1373
		11	1273	538	0	0	1812	0	0	25	0	25	1787
		21	2084	948	0	0	3033	0	265	835	0	1100	1933
		23	2452	1608	0	0	4060	0	0	2055	0	2055	2005
		25	1346	881	0	0	2226	0	231	212	0	443	1783
		48	1321	294	0	0	1614	0	220	0	0	220	1394
		49	1513	574	0	0	2087	8	188	371	0	567	1520
		70	1883	599	0	0	2482	0	87	385	0	472	2010
		76	1492	898	0	0	2390	0	207	435	0	641	1749
		84	2913	948	0	0	3861	0	265	1625	0	1890	1971
		86	2222	435	0	0	2656	0	125	502	0	627	2029
	Non irrigation users food Insecure households	12	439	959	0	0	1398	0	71	110	0	182	1216
		16	1513	805	0	0	2318	10	135	295	15	456	1863
		17	642	614	0	0	1256	0	101	0	0	101	1156
		19	244	1349	0	0	1593	0	8	0	0	8	1585
		32	2688	120	0	257	3066	0	438	1234	0	1672	1394
		36	2179	433	0	0	2613	0	253	1338	50	1641	971
		38	3054	16	0	0	3070	0	527	514	0	1041	2029
		39	3010	297	0	0	3307	0	198	1646	0	1844	1462
		55	693	1526	0	0	2219	0	178	0	0	178	2040
		56	211	969	0	40	1219	0	0	0	0	0	1219
		57	990	1100	0	0	2090	0	211	248	0	459	1631

		58	2541	197	0	0	2738	0	410	979	82	1471	1267
		59	1564	447	0	0	2011	0	247	0	0	247	1763
		60	1511	489	0	0	1999	0	43	0	0	43	1956
		61	281	965	0	0	1246	0	0	0	0	0	1246
		63	587	587	0	0	1174	0	37	0	0	37	1137
		65	1738	199	0	0	1936	0	205	0	205	411	1525
		67	877	1027	0	0	1905	0	248	248	0	496	1408
		69	2345	367	0	0	2712	0	345	566	0	911	1801
		78	549	989	0	0	1538	0	15	110	0	125	1413
		79	659	959	0	0	1618	0	80	110	28	218	1400
		81	281	1285	0	0	1566	0	159	0	0	159	1407
		91	907	1044	0	0	1951	0	154	199	0	353	1598
		93	1738	199	0	0	1936	0	62	0	103	164	1772
		95	734	587	0	0	1321	0	37	0	0	37	1284
		97	2713	205	0	0	2918	0	432	901	82	1415	1503
		99	281	965	0	37	1283	0	0	0	0	0	1283

Source: own survey (2014)

Annex 4: Household annual income generated from irrigation farm casual labor in survey year in birr

Income generated in birr	Frequencies			Total income generated in birr		
	non irrigation user households	irrigation user households	Total	non irrigation user households	irrigation user households	Total
960	1	0	1	960	0	960
1000	0	2	2	0	2000	2000
1200	1	1	2	1200	1200	2400
1250	1	1	2	1250	1250	2500
2000	1	0	1	2000	0	2000
2400	0	1	1	0	2400	2400
2500	0	1	1	0	2500	2500
3000	2	0	2	6000	0	6000
3200	1	0	1	3200	0	3200
3600	1	1	2	3600	3600	7200
3800	1	0	1	3800	0	3800
4000	0	1	1	0	4000	4000
4300	1	0	1	4300	0	4300
4500	1	0	1	4500	0	4500

4600	1	0	1	4600	0	4600
5500	1	0	1	5500	0	5500
6000	0	1	1	0	6000	6000
6500	0	1	1	0	6500	6500
7200	0	1	1	0	7200	7200
7500	0	2	2	0	15000	15000
8000	0	1	1	0	8000	8000
8500	0	3	3	0	25500	25500
10000	0	1	1	0	10000	10000
12500	0	1	1	0	12500	12500
14400	1	0	1	14400	0	14400
Total	**14**	**19**	**33**	**55,310**	**107,650**	**162,960**
Average				**3,951**	**5,666**	**4,938**

Source: own survey (2014)

Annex 5: Household annual income from irrigation farm casual labor used for food purchase last year in birr

Income generated in birr	Frequencies			Total income shared for food purchase in birr		
	non irrigation user households	irrigation user households	Total	non irrigation user households	irrigation user households	Total
0	2	1	3	-	-	-
384	1	0	1	384	-	384
400	0	1	1	-	400	400
500	1	2	3	500	1,000	1,500
800	0	1	1	-	800	800
1000	1	2	3	1,000	2,000	3,000
1200	2	1	3	2,400	1,200	3,600
1250	0	1	1	-	1,250	1,250
1400	0	1	1	-	1,400	1,400

1500	1	2	3	1,500	3,000	4,500
1800	2	0	2	3,600	-	3,600
2000	3	0	3	6,000	-	6,000
2500	0	2	2	-	5,000	5,000
3000	0	3	3	-	9,000	9,000
3500	0	1	1	-	3,500	3,500
4000	0	1	1	-	4,000	4,000
7200	1	0	1	7,200	-	7,200
Total	**14**	**19**	**33**	**22,584**	**32,550**	**55,134**
Average				**1,613**	**1,713**	**1,671**

Source: own survey (2014)

Annex 6 Research Tools

Questionnaires designed for sampled household survey to assess the contributions of smallholder Irrigation to household food security in Central Rift Valley of Ethiopia

I. General Information

1. Code of the household head_____
2. Name of the Kebele 1) Abbino Gabrael 2) Wayyo Gabrael 3) Doddota Dembel
3. Type of the household farm in use right 1) irrigation only 2) rain fed only 3) both irrigation and rain fed
4. Age of the household head (in years) _____
5. Sex of the household head; 1) Male 2) Female
6. Household head educational level; 1) Illiterate 2) Read and write 3) Years of formal education (if any)_____
7. Marital status of the household head; 1) Married 2) Single 3) Divorced 4) Widowed
8. What is your household size in terms of age category and sex?

Age category in years	Male	Female	Total
Less than 15			
15 to 64			
Above 64			
Total			

9. Household farmland holding condition (hectare) in the last year:

Holding condition	Crop land		Other land	
	irrigated	Rain fed	Grazing	homestead
Use right				
Rented in				
Shared in				
Rented out				
Shared out				

II. Household livelihoods base and institutional support

10. What is your main livelihoods source1) crop farming 2) livestock 3) mixed farming 4) off farm and nonfarm 5) others _____

11. What is your water source for irrigation (if any irrigation)? 1) Shallow well 2) Lake 3) River 4) Other_____

12. If you use irrigation when did you engage in irrigation activities of your own (years)?___

13. What power did you use to cultivate your land in the last year? 1) Tractor 2) Oxen 3) tractor and Oxen 4) other_____

14. How many times do you produce crops from a piece of land annually (example last year)?___

15. How many of your family members whose age ranges from 15 to 64 are involved in crop farming activities? _____

16. Do you hire labour for crop farming? 1) Yes 2) No

17. What is the total amount of the following inputs you have used in the last year (quintal/Kg)?

Type of inputs	unit	Irrigated farm	Non irrigated farm
Inorganic fertilizer	Quintal		
Compost/manure	Quintal		
pesticide	Kg		

18. Did you use improved seed in the last year? 1) Yes 2) No
19. How often did the development agent/s visit you in farming in the last year?

Farming activity	**Number of visit**
Land preparation	
Crop field management	
Harvesting and storing	

20. Could you get credit (in cash or kind) in the last year for farming? 1) Yes 2) No

21. If your answer to Qn#20 is yes, what are the sources?

Source	**Response**	
	yes	**No**
Bank		
Micro Finance		
Iddir		
Local money lenders		
NGO		
Union		
Friend		
Other (specify)		

22. If your answer to Qn# 20 is yes, for what purpose you usually take the credit (multiple answers possible)? 1) Purchase of improved seeds 2) Purchase of fertilizer 3) Purchase of chemicals 4) Purchase of oxen 5) Purchase of small ruminant animals 6) Others (specify) _____

23. What is the number of key livestock owned by your household now?

S/N	**Livestock type**	**Number of livestock**
1	Cows local breed	
2	Cows improved breed	
3	Heifers and calves	
4	Oxen	
5	Sheep / goats	
6	Donkeys	
7	Horses/ mules	

III. Food security condition

24. What was food grain availability for your family consumption during last year period in quintal?

SN	Food grain type	Amount produced	Amount bought	Amount Food aid	Amount gained by gift	Amount lost after harvest	Amount reserved for seed	Amount sold	Amount given to others
1	Maize								
2	teff								
3	wheat								
4	barley								
5	Beans								
6	Lentils								
7	sorghum								
8	other (specify)								

25. What was the amount of food grain production you got from irrigation farm of your use right land, share cropping and land renting in quintal in last year?

SN	Food grain type	Amount produced from own use right land	Amount produced from share cropping /renting in irrigable land
1	Maize		
2	teff		
3	wheat		
4	barley		
5	Beans		
6	Lentils		
7	sorghum		
8	Others (specify)		

26. Did any one of your household member participate in any non farming or off farm activity in the last year

Type of activity	yes	No	Annual income in Birr	Income used for food purchase in Birr
Wood and wood product selling				
Weaving and other hand craft				
Sand collection				
Fishing				
Grain trading				
Vegetable trading				

Livestock trading				
Local drink preparation				
Land renting				
Casual labour (other than irrigation farm)				
Casual labour on irrigation farm				
Cart driving				
Employment against monthly payment				
Animal fattening				
Other				

27. Did you sold livestock in the last year? 1) Yes 2) No

28 If you sold livestock in the last year what was the total income generated from it in birr_____

29. If you sold livestock in the last year what was the share for food purchase in birr_____

30. What was the amount of income your household generated from sell of vegetables/fruits produced from irrigation farms of your own or rented in or shared in lands in last year (in Birr)?

_____

31. If your household generated income from sell of vegetable/fruits produced from irrigated farm in last year, what was the share for food purchase in Birr_____

32. In which months your household has been food secure and faced food shortage in the last year (tick *x*)?

Food condition	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Food secure												
Food shortage												

33. If your household encountered food shortage last year, what was the reason for it (multiple answers possible)?

1) Land shortage 2) oxen shortage 3) labour shortage 4) Poor land fertility 5) Farm implements shortage 6) crop failure due to erratic rain fall) 7) market failure to sell produce 8) market problem to buy food 9) inputs problem 10)others (specify)

_____

34. How do you usually cope with the food shortage you encounter (multiple answers possible)? 1) rent in land 2) rent out land 3) borrow money4) borrow cereals 5) livestock sell 6) labourer in irrigation farm 7) labourer in other activities 8) involve in other off farm/nonfarm activities 9) Fuel wood selling 10) other (specify) _____

35. What is the number of meals per day in your household through the following seasons last year? (Circle the number)

Seasons	**Number of meals per day**			
January to March	1	2	3	4 or more
April to June	1	2	3	4 or more
July to September	1	2	3	4 or more
October to December	1	2	3	4 or more

36. What average milk consumption per day of your household in litre was last year?_____

37. How often did your household members eat food like beef and eggs in the last year? 1) Often 2) sometimes 3) on holydays only 4) never

38. How often did your household members eat food like green bean, cabbage and tomato in the last year? 1) Often 2) sometimes 3) on holydays only 4) never

39. If your household consumed vegetables mentioned under Qn# 38 what was the source (multiple answers possible)

1) Purchased 2) production from own irrigable land 3) production from shared/rented in irrigable land 4) gift from others who own irrigable land 5) others (specify)

_____

IV. Challenges of pump irrigation system (for irrigation user households only)

40. What are the technical challenges from small pump irrigation your household encountered last year?

Type of technical challenges	**Extent of the challenge (circle)**			
	None (=0)	**Low(=1)**	**Medium(=2)**	**High(=3)**
Poor land quality	0	1	2	3
Irrigation water shortage	0	1	2	3
Poor inputs quality	0	1	2	3
Poor irrigation infrastructure	0	1	2	3
Frequent pump failure	0	1	2	3
Limited knowledge and skill in agronomy	0	1	2	3
Limited skill in pump operations	0	1	2	3
Limited skill of pump maintenance	0	1	2	3
Salinity	0	1	2	3
Crops disease	0	1	2	3
Vegetable crops short shelf time	0	1	2	3
Other technical challenges (specify)	0	1	2	3

41. Have you ever faced any problem of crop failure due to water scarcity?1) Yes2) No

42. If your answer to Qn# 41 is yes, why? (Multiple answers possible)

1) Lake or ground water receding 2) poor distribution schedule 3) Pump breakage & poor maintenance 4) lack of fuel for pump 5)Others (specify) _____

43. Have you ever received training on the following issues in the last year?

Type of training	Response	
	Yes	No
WUA/cooperative management		
Soil fertility management		
Irrigation water management		
Bed preparation and vegetable nursery management		
Planting of vegetable seedlings		
Weeding and pest management		
Proper Inputs selection & their application		
Crop harvesting& post harvest management		
Pump operation and management		
Inputs and outputs marketing		
Other training you received (specify)		

44. What are the institutional and management related challenges of small pump irrigation development and management you feel?

Type of institutional related challenges	Extent of the challenge (Circle)			
	None (=0)	Low(=1)	Medium(=2)	High(=3)
Irrigation land adequacy	0	1	2	3
Water users Association governance	0	1	2	3
Accessing adequate credit/ finance	0	1	2	3
Accessing extension services	0	1	2	3
Input and outputs marketing	0	1	2	3
Getting Pump maintenance services	0	1	2	3
Conflict in water utilization	0	1	2	3
Labour shortage	0	1	2	3
Absence or limited government support	0	1	2	3
Other institutional challenges (specify)	0	1	2	3

45. Are you a member of water user association or cooperative? 1) Yes 2) No

46. If your answer to Qn #45 is yes, how do you evaluate the strength of your water user association/cooperative committee?1) Very strong 2)Strong 3) Weak 4) Very weak

Thanks

Checklist for Key Informant Interview at Kebele level

1. What does the rain trend seem over the last ten years?
2. What are the difference between irrigation users and non user household interns of production and other assets?
   What are the major challenges in the process of production and marketing of farm inputs and out puts in your locality?
3. What do food security; food stability, food diversification and coping strategy seem in your village?
   What are the reasons for food insecurity and sections of society most affected in your village?
4. How do livestock and off farm or nonfarm activities are contributing to food security in your locality
5. How irrigation is accessed and how it is contributing to the food security of irrigation users and non users in your village?
6. What are the technical challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security in the area?
7. What are the institutional challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security in the area?
8. What do you think are solutions to the challenges encountering irrigation development and management in order to ensure food security in your village?

Checklist for Key Informant Interview government, Union and NGOS staffs

1. What are your responsibilities in the irrigation development and management or ensuring food security?
2. How do you see the food security condition of the district and what are the causes of food insecurity in the district
3. What is the status of irrigation development in the district and how it contributes to rural household food security
4. What are the technical challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security
5. What are the institutional challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security
6. How are you trying to solve the challenges and which challenges are above your capacity? Why?
7. What do you think are solutions to the challenges encountering irrigation development and management in order to ensure food security

Checklist for Focus Group discussion at Kebele level

1. What does the rain trend seem over the last ten years?
2. What are the difference between irrigation users and non user household interns of production and other assets?
3. What are the major challenges in the process of production and marketing of farm inputs and out puts in your locality?
4. What do food security; food stability, food diversification and coping strategy seem in your village?
5. What are the reasons for food insecurity and sections of society most affected in your village?
6. How do livestock and off farm or nonfarm activities are contributing to food security in your locality
7. How irrigation is accessed and how it is contributing to the food security of irrigation users and non users in your village?
8. What are the technical challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security in the area?
9. What are the institutional challenges in the development and management of pump irrigation systems? How do they affect the irrigation development and management and food security in the area?
10. What do you think are solutions to the challenges encountering irrigation development and management in order to ensure food security in your village?