ST.MARRY UNIVERSITY

INSITUTE OF AGRICULTURE AND DEVELOPMENT STUDIES

BY

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ADDIS ABABA, ETHIOPIA

A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS SCHOOL OF GRADUTE STUDIES ST.MARY UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF AGRUCLTURAL ECONOMICS

COMPARISON OF IRRIGATION BASED AGRO-PASTORALISTS WITH PASTORALISTS LIVELIHOOD IN CASE OF DOLO ADO AND DOLO BAY WOREDAS, SOMALI REGION, ETHIOPIA

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APPROVED BY BOARD OF EXAMINERS

As a member of Board of Examiners of the MSc Thesis open Defense, we certify that we have read and evaluated the Thesis prepared by Sisay Tekola; we recommended that the Thesis to be accepted since it fulfills the Thesis requirements for the Degree of Master Of Science in Agricultural Economics.

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DECLARATION

I hereby declare that this thesis is my own work and has not been submitted for any other degree. All sources of materials used for this thesis have been duly acknowledged.

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ENDORSMENT

This is to certify that this thesis entitled: **COMPARISON OF IRRIGATION BASED AGRO-PASTORALISTS WITH PASTORALISTS LIVELIHOOD IN CASE OF DOLO ADO AND DOLO BAY WOREDAS IN SOMALI REGIONAL STATE** is an authentic work of _____ ID.No._____who carried out the research under my guidance. I certify that, to the best of my knowledge, the work reported here does not form part of any project report or thesis on the basis of which a degree or award was conferred on an earlier occasion on this or any candidate.

Advisor:_____Signature:_____Date:_____

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ABSTRACT

Investment in irrigation can relieve agro-pastoralists from high dependence on rainfall, increases irrigated farmland, encourages agro-pastoralists to produce two or three times in a year and provide job for the poor. However, it is not well known to what extent agro-pastoralist households who are practicing irrigation are better off than pastoralist households which are not practicing irrigation in the study area Genale-Dawa livelihood zone. Given this fact, this study tried to provide explicit empirical evidences through comparing irrigation based livelihood of agro-pastoralists with pastoralist households. The study also assessed challenges encountered by agro-pastoralist households during irrigation intervene. In this study, multi-stage and simple systematic random sampling procedure were applied for the selection of sample respondents and accordingly 66 (33 agro-pastoralists and 33 pastoralists) households were selected from the same livelihood zone to minimize heterogeneity except irrigation practice and interviewed based on developed structured and semi-structured questionnaires. The only differences livelihood between the sampled agro-pastoralist and pastoralist households were practicing irrigation even if they are living the same livelihood zone. River water is the only source for irrigation in the area. Beside structured and semi-structured questionnaires, 4 FGD discussions and 10 key informant interview were made. Moreover, secondary data were collected from literatures, books, internet, and reports of governmental and non-governmental organizations. Statistical descriptive method was employed to compare the livelihood of irrigation based agro-pastoralist with pastoralist households and challenges that affecting agro-pastoralists and pastoralists in the study area by using SPSS software. The study result shows that the major challenges encountered in practicing irrigation that respondents from agro-pastoralists have stressed are loss of water and easily damage of soil fenced canal in the study area. Moreover the study shows that irrigation practice also affected by gender of the household head, accessibility to river and education level of the household head.

On the comparison of income of irrigation based agro-pastoralist and pastoralist shows that, the total annual household income in the study area was ETB 176,185.58 (123,374.76 ETB for agro-pastoralist and 52,810.82 ETB for pastoralist households), from this total annual income of a household, livestock contributes the highest income share (57.2%), cropping (31.5%) and off-farm

(11.3%), respectively. Agro-pastoralist households earn higher income from cropping than pastoralist households, which is indicating that irrigation practice increases household farm incomes. In terms of annual aggregate income which showed in the study agro-pastoralist was significantly higher income and has 70,563.94 ETB difference compared to the annual income of pastoralist households. This implies that the probability of being poor decreases if one has engaged in crop cultivation, other factors being constant. Moreover, this suggests that engaged in crop cultivation has significant contribution on improving annual income than only being pastoralist.

Key words: Irrigation, Agro-pastoralist and Pastoralist

ACRONYMS

ADB	African Development Bank
ADLI	Agricultural Development Led Industrialization
ASAL	Arid and Semi -Arid lowlands
CBN	Costs of Basic Needs
CSA	Central Statistic Authority
DACY	Disability-Adjusted Life-Years
DFID	Department for International Development
DMFA	Dutch Ministry of Foreign Affairs
ETB	Ethiopian Birr
FAO	Food and Agricultural Organization of the United Nations
FGD	Focus Group Discussion
GDP	Gross Domestic Product
Ha	Hectare
HH	Household
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPTRID	International Programme for Technology and Research in Irrigation and Development
IWMI	International Water Management Institute
KG	Kilo-germ
KM	Kilometer
LSI	Large Scale Irrigation
M	Meter

Mha	Million Hectares
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resource
MSI	Medium Scale Irrigation
MW	Mega watt
N/A	Not Available
NGOs	Non-Governmental Organizations
OLS	Ordinary Least Square
PARIMA	Pastoralist Risk Management
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSM	Propensity Score Matching
PPP	Purchasing Power Party
PSNP	Productive Safety Net program
ReSAKKs	Regional Strategic Analysis and Knowledge Support System
RWH	Rain Water Harvesting
SPSS	Statistical Package for Social Science
SRSE	Somali Regional State Ethiopia
SSNRP	Southern State of Nationalities Regional People
SSA	Sub-Saharan Africa
SSI	Small Scale Irrigation
TLU	Tropical Livestock Unit
UN	United Nations
UNDP	United Nations Development Program
WCD	World Commission on Dams

WLCRDO Woreda Livestock and Crop Rural Development Office

1. INTRODUCION

1.1 Background of the study

Historically, irrigation originated as a method for improving natural production by increasing the productivity of available land and thereby expanding total agricultural production especially in the arid and semi-arid regions of the world. Availability and access to irrigation was considered essential for crop production, asset creation and expansion of development frontiers.

Irrigation programs and related technologies are also relatively well known in Ethiopia, and the government actively promoted these schemes during the 1970s and 1980s. However, during the 1990s many irrigated state farms were abandoned and investment in large-scale and medium-scale schemes stagnated. At the same time, there was a corresponding expansion of small-scale communal irrigation schemes. Until recently there has been relatively limited government investment in improving these traditional small-scale irrigation schemes or in expanding modern schemes either through providing incentives to encourage private sector involvement, or through government research and extension programs (Awulachew, 2010).

The government's Water Sector Development Strategy (2002) and Plan for Accelerated and Sustained Development to End Poverty (PASDEP)(2005/6-2009/10) emphasizes the importance of irrigation development in stimulating rural economic growth and development, and ensuring long-term food security.

The current government has undertaken various activities to expand irrigation in the country. The country's Agricultural Development Led Industrialization (ADLI) strategy considers irrigation development as a key input for sustainable development. Thus, irrigation development, particularly small-scale irrigation is planned to be accelerated (MOFED, 2010).

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

However, an estimate of the potential irrigable area in the country varies. For instance the Somali region agro-pastoral and pastoral area, from total irrigable potential of 500,000 ha, of which only around 12,000 ha (2.4%) was under irrigation of any kind. Of this, the report estimates only 1,800 ha (15%) to be under modern small-scale irrigation schemes, whilst around 8,200 ha was under traditional small- scale irrigation (IWWI, 2005).

However, there are growing pressures to expand and to intensify irrigation within the region as a result of changing livelihood strategies, demand for food, cash crops, and feed for livestock. There is also a tendency for the human and livestock population to move towards the river valleys and dry season grazing areas more permanently. In the study area there are no currently significant water uses in the River Basin of Genale-dawa when we compare with the available potential of the area. Agricultural economy is predominantly based on small scale rain-fed subsidence farming and small-scale irrigation schemes for cash crop production. In the highlands their livelihoods are mainly depend on crop production while in the lowlands area where rainfall is inadequate and the livelihoods are primarily dependent on livestock production. However even if the effort was small, nongovernmental organizations like Save the Children International has been engaged in funding and implementing irrigation dams and river diversion structures in the study area. After constructed, these irrigation infrastructures are handed over to water users associations on the principle that local farmers will have a comparative advantage over the government through collective action. Another thing, irrigation is not a simple silver bullet (Awulachew, 2010). It brings positive returns only if it is complemented by other components of the agricultural system. Unfortunately, the country's agricultural sector is characterized by traditional technologies and poor systems.

According to the Genale-Dawa River Basin Master Plan Study of Ethiopia in the year 2006, 93 medium and large scale schemes with over a million hectares of potential irrigable land areas were proposed for irrigation consuming a large amount of water available in the basin. After a further study, they were reduced to 10 candidate projects of irrigation. The master plan, which was finalized and presented in 2007, identified 22 dam projects for potential hydropower development. After further screening, 9 dam projects were shortlisted. These 9 dams will be implemented in different periods of time, stretching from 2013 to 2035. The economic hydropower potential of these dams is estimated to 1300 MW. Ethiopia is planning to export hydropower to its neighboring countries to earn desperately needed foreign currency. The plans include also water supply schemes. Specifically, there are different production constraints impeding performance of the irrigation sector. These gaps are

technical, agronomic, financial, infrastructural and institutional. Hence, quantifying the explicit impact of irrigation schemes deems essential.

Moreover; Irrigation has served as one key driver behind growth in agro-pastoralists in agricultural productivity, increasing household income and alleviation of poverty, which highlights the various ways that irrigation could have contribution to enhance and improve the livelihood of agro-pastoralists. According to Lipton et al. (2004) cited by Haile (2008), there are four interrelated mechanisms by which irrigated agriculture can reduce food insecurity in agro-pastoralist and pastoralist areas through:(i) increasing production and income, and reduction of food prices, that helps very poor households meet the basic needs and associated with improvements in household overall economic welfare, (ii) protecting against risks of crop loss due to erratic, unreliable or insufficient rainwater supplies, (iii) promoting greater use of yield enhancing farm inputs and (iv) creation of additional employment, which together enables people to move out of the poverty cycle. In the same way, Zhou et al. (2008) mentioned that irrigation contributes to agricultural production in agro-pastoralists in two ways: increasing crop yields, and enabling agro-pastoralists to increase cropping intensity and switch to high-value crops.

1.2 Statement of the problem

Since the middle of the 20th century agro-pastoralists and pastoralists in the dry lands of Ethiopia have been faced with an increasing number of critical challenges that fuel the debate of the decline of pastoralism as stated by Scholz (2008) and its potential for adaptation stated by Davies and Bennett (2007). In addition to high climate variability and recurrent droughts and floods, especially pastoral livelihood systems have been severely constrained by multiple violent conflicts over natural resources and contested political claims, as well as increasing governmental development interventions such as the expansion of irrigation agriculture and settlement projects as describe by Ayalew (2001) . Due to the massive loss of communally-held grazing areas and mobility under conditions of a generally growing population, processes of impoverishment and increasing vulnerability have become characteristic for large parts of the pastoral population who inhabit 60 percent of the Ethiopian territory when we compare with agro pastoralists(Devereux ,2006).

Moreover, in a great many cases the pastoral water supply systems have been so unsustainably managed that they have failed to provide adequate water even in times of great

need, i.e. during droughts. Improper planning for the financing and development of water sources, and day to day water service provision (for domestic/livestock needs) are common. Even the intervention and support given is inappropriate, targeted and demand driven for the long term. Many reports, studies and water actors' observations have identified numerous problems that contribute to the unsustainable financing/development of water and water services provision in pastoral and agro-pastoralist areas, and the lack of consideration for their social and environmental impact. These contributed for inadequate infrastructure, which is often unfairly distributed due to inadequate financing. Environmental degradation due to inappropriate placement of permanent water sources, which causes degradation of the fragile rangeland environment and leads to loss of grazing areas, conflicts and increased vulnerability of pastoral communities to drought. Inappropriate technology choices, which the community cannot sustainably manage, and Poor design and construction of the water structures (UNDP, 2007).

After the overthrown of the military regime in 1991 Ethiopia gone into a new process of planning its internally available water resources. However, still the country has not yet been using the water resources of the rivers. The Ethiopian master plans of the Wabi Shabelle and Genale-Dawa river basins in Somali regional state reveal that the proposed major increase of water use for agricultural and energy productions in Ethiopia demand large scale mobilization of the available water resources in the rivers. The proposed large dams and irrigation schemes have the capacities to utilize all available water resources in the two rivers however still not implemented as needed.

In the study area in Genale–dawa livelihood zone in Dolo Ado and Dolo Bay, Somali regional states traditional small scale irrigated land currently extends 144km along the Dawa and 80km along the Ganale Rivers. In this livelihood zones small scale irrigation schemes has been established by government and NGOs with limited numbers in order to improve the livelihood of agro-pastoralist and pastoralist households living in the area. To the researcher's knowledge, however, there are no empirical findings to witness whether or not irrigation based agro-pastoralists have been benefited from the available irrigation schemes with the comparison of pastoralists who are not yet practicing irrigation in the study livelihood zone. It is, therefore, advisable to compare irrigation based agro-pastoralist livelihood with pastoralist for future directions and policy design to improve the area.

Many studies like (Huang etal. 2005) in China; (Kuwornu and Owusu, 2012) in Ghana; (Haji and Aman, 2013) in Ethiopia found positive impacts of irrigation on agro-pastoralist livelihoods. However, it is not well known to what extent the households using irrigation are better off than those who do not practice the system in the study area. The levels of income of the agro-pastoralists can be taken as one of the indicators of the livelihood status of the agro-pastoralists. The existing potentials and efforts to increase income of the agro-pastoralists and pastoralists through irrigation are known minimum. An in-depth comparative analysis of household income difference taking into account irrigation activity is also limited.

In Somali region, to the best of my knowledge, the benefit of river diversion irrigation schemes is not well documented. Besides, no attempt has been made to compare the livelihood of irrigation based agro-pastoralists better than pastoralist households around Genale-Dawa river basin irrigation scheme so far. Given these facts, my study tries to provide explicit empirical evidences about the contribution of irrigation on the improvement of the agro-pastoralist livelihood with comparing pastoralist households. At the same time to contribute to the existing knowledge and understanding of development actors in their future planning and development of small-scale irrigation schemes. The study also assessed challenges encounters by agro-pastoralists during irrigation intervene through focus group discussion and key informant interviews to give attention by government and for other interest groups.

1.3 Objectives of the study

The main objective of the study was to compare the irrigation based agro-pastoralist livelihood with pastoralist and identify major challenges of the use of irrigation system in the Genale- dawa river basin livelihood zone in the cases of Dolo Ado and Dolo Bay woredas.

The specific objectives of the study were including:

- To compare the irrigation based agro-pastoralists livelihood with pastoralist livelihood.
- To identify major challenges of the use of irrigation systems in the study area.

1.4 Research questions of the study

Main research questions of this study were focus on the following issues:

- What are the major differences between agro-pastoralist and pastoralist livelihood in the study area?
- What are the major challenges faced by agro-pastoralists while using irrigation in the study area?

1.5. Hypothesis

The Hypotheses of this study were:

Ho: Being irrigation based agro-pastoralist has a positive contribution on farm household livelihood.

H1: Being irrigation based agro-pastoralist has no contribution on non-farm household livelihood.

1.6. Significance of the study

Many scholars said that irrigation development was assumed as mechanisms to improve agricultural production and productivity especially in drought and rainfall shortage area and it play a great role in poverty reduction and ensure food security in our country Ethiopia. But in many parts of Ethiopia, the success of irrigation system is highly affected by socio-economic and institutional factors. However, little attempt has been undertaken to identify such specific factors and to reduce this national problems in the study area.

Therefore, this study conducted to compare irrigation based agro-pastoralist livelihood with pastoralists and the major socio-economic factors which affect the utilization of small-scale irrigation water in the study area. Thus, the result of this paper would be used by the policy maker for planning of appropriate programs in response to small-scale irrigation water utilization by agro-pastoralist households. Similarly, the finding of this study can be used by individual researchers, the community, governmental and non-governmental organizations who are working in the woreda on agricultural development. These stakeholders' can take intervention measures and set appropriate plans to improve the existing level of irrigation practice among the community and it would be used as a base line data for further studies.

1.7. Scope and Limitations of the Study

The study is limited to only two woredas due to resource and time limitation. Moreover, there was a treat of security issue related with Al Shebab around the boarder of Kenya and Somalia, especially around Dawa river basin due to this, we enforced to limit small sample size. In this study, household level production data of only one year period from February 2013 to January 2014 were used.

During the course of survey work we found that agro-pastoralists and pastoralists reluctant to frankly respond to some of the questions particularly to questions of resource holding especially on number of livestock own. Moreover, the hot weather condition of the area and scattered population found challenge for enumerators as well as the respondents to discuss with them in relaxation way. To solve these problems the data collectors enforced to wait until evening and planning together with respondents the appropriate time for them to maintain the quality of the data.

2.REIVEW OF LETRITURE

This part of the study covers different findings done by different researchers on irrigation , pastoralist and agro-pastoralist related issues and covers different topics like overview on agro-pastoralist, pastoralist and irrigation, irrigation- poverty linkages, importance of irrigation and understanding vulnerable livelihood in pastoralist and agro-pastoralist of Ethiopia, contribution of irrigation on socio-economic, nutrition and health of the agro-pastoralist communities, water and irrigation in Ethiopia,

2.1 Overview on agro-pastoralists, pastoralists and irrigation

Pastoral production remains the dominant land use in Ethiopia's lowlands, which occur below an elevation of 1500m and constitute between 54% and 61% of the country's surface area (Coppock, 1994).

Pastoralists are defined variously in the literature as those who obtain more than half their income from livestock and livestock products and who characteristically practice mobility to avoid risk, respond to variable climatic conditions and ensure healthy livestock and rangelands. A further category of agro-pastoralists is defined as those who practice some degree of mobility but obtain less than half their income from livestock, with most of the remainder coming from crop cultivation (Nagda and Mulugeta, 2012).

The lowlands of Ethiopia account two-thirds of the national land area and 12% of the population of Ethiopia. Their primary livelihood is the management of livestock-cattle, goats, sheep and camels. The severity of the problem in these regions and the need to find ways to promote sustainable livelihood based on pastoralism and agro-pastoralism prompted a request by the Government of Ethiopia to its development partners for funding to search for solutions (Nagda and Mulugeta, 2012).

Irrigated agriculture can be defined as agriculture where the supply of water is increased by artificial means, involving the use of water control technology and including drainage to dispose of excess water (IPTRID,1999).

Historically, irrigation originated as a method for improving natural production by increasing the productivity of available land and thereby expanding total agricultural production especially in the arid and semi-arid regions of the world. Availability and access to irrigation

was considered essential for crop production, asset creation and expansion of development frontiers. Rapid expansion of irrigated areas in the recent past, coupled with availability and access to new technology high yielding varieties (HYV), fertilizers and tube well and water extraction mechanisms in the late 1960s and 1970s were major underlying factors for the success of the green revolution in Asia. Better access to irrigation infrastructure facilitated intensification of cropping practices and inputs used, thus paving the way for the "modernization" of the agricultural sector Intizar eta al (2004).

Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty. About 17 percent of global agricultural land is irrigated and contributes about 40 percent of the global production of cereal crops WCD (2000). In addition to food security, irrigated agriculture significantly contributes towards generating rural employment and maintaining rural livelihoods, which is particularly important in the context of declining real world market food prices.

However, Irrigation development is not free from controversies. It has been argued that irrigation developments in various regions has displaced marginal and poor farmers and have made them landless laborers and ultimately driven them to become urban dwellers Chambers (1988). Likewise, the social disruption of rural poor due to large-scale irrigation systems and reservoir construction, payment of inadequate compensation to displaced persons and increased incidence of water-borne diseases in irrigation commands are other potential negative impacts associated with irrigation development. Increased waterlogging and soil salinity buildup due to poor provision of drainage facilities in irrigation systems are also often cited as negative environmental impacts of irrigation Intizar eta al. (2004).

However, the positive impacts of irrigation infrastructures could far outweigh some of these negative impacts, which can be potentially minimized or can be duly compensated through improved planning and management of irrigation systems. The total benefits and distributional impacts of irrigation services depend upon the nature and type of irrigation infrastructure: whether it is a large irrigation command, or a minor tank irrigation scheme or a tube well irrigation scheme.

Past irrigation-related research has largely been focused on general agricultural productivity increases and improvement of irrigation system performance through technical and physical interventions. Not only does poverty performance, particularly of medium- and large-scale

canal irrigation systems, remain largely unknown, but little scientific knowledge exists on key determinants of interventions to enhance antipoverty contribution of irrigation. This study aims to contribute to filling the gap of study on the same topics and compare irrigation based agro-pastoralist livelihood with pastoralist household and challenges of irrigation practices in the study area.

2. 2. Irrigation-Food Security Linkage

This conceptual framework indicates that investment in irrigation schemes can relieve agro-pastoralists from high dependence on rainfall. It increases irrigated farmland and also generates employment. It encourages agro-pastoralists to produce two or three times in a year and use more of chemical inputs. Studies show that small scale irrigation in developing countries was counted on to increase production, reduce the dependence effects of unpredictable rainfall and provide jobs to the poor (Chazovachii 2012, Torell and Ward 2010). Irrigation in semi-arid tropical countries is an important investment rural development that can have direct and indirect contribution on food security and poverty (Bhattarai et al. 2007). Investment in small-scale irrigation creates on/non- farm employment opportunities; increases consumption expenditure and accumulating assets. Accordingly, irrigation lowers food prices so that the poor can afford and get access to the required food at fair prices (Huang et al. 2006).

Use of more chemical inputs and year round production in irrigated farmland improves productivity, and shifts from subsistence crops to high-value cash crops, which in turn enable people to take nutritious food and keep good health status. Awulachew et al. (2007) explained that irrigation development increases productivity of inputs, mitigate vulnerability of rainfall variability, and promote rural dynamic economy. Reliable small scale irrigation increases land productivity, crop yields and application of mineral fertilizers, which, in turn, enables to diversify into non-conventional and market-oriented products (high value crops, vegetables and fruits (Eshetu 2010), which positively improves farm households' diet, incomes, health and food security (Torell and Ward 2010). Thus, the study built the model to illustrate the contribution of small scale irrigation in ensuring food security and attracting inward investment in the economy.

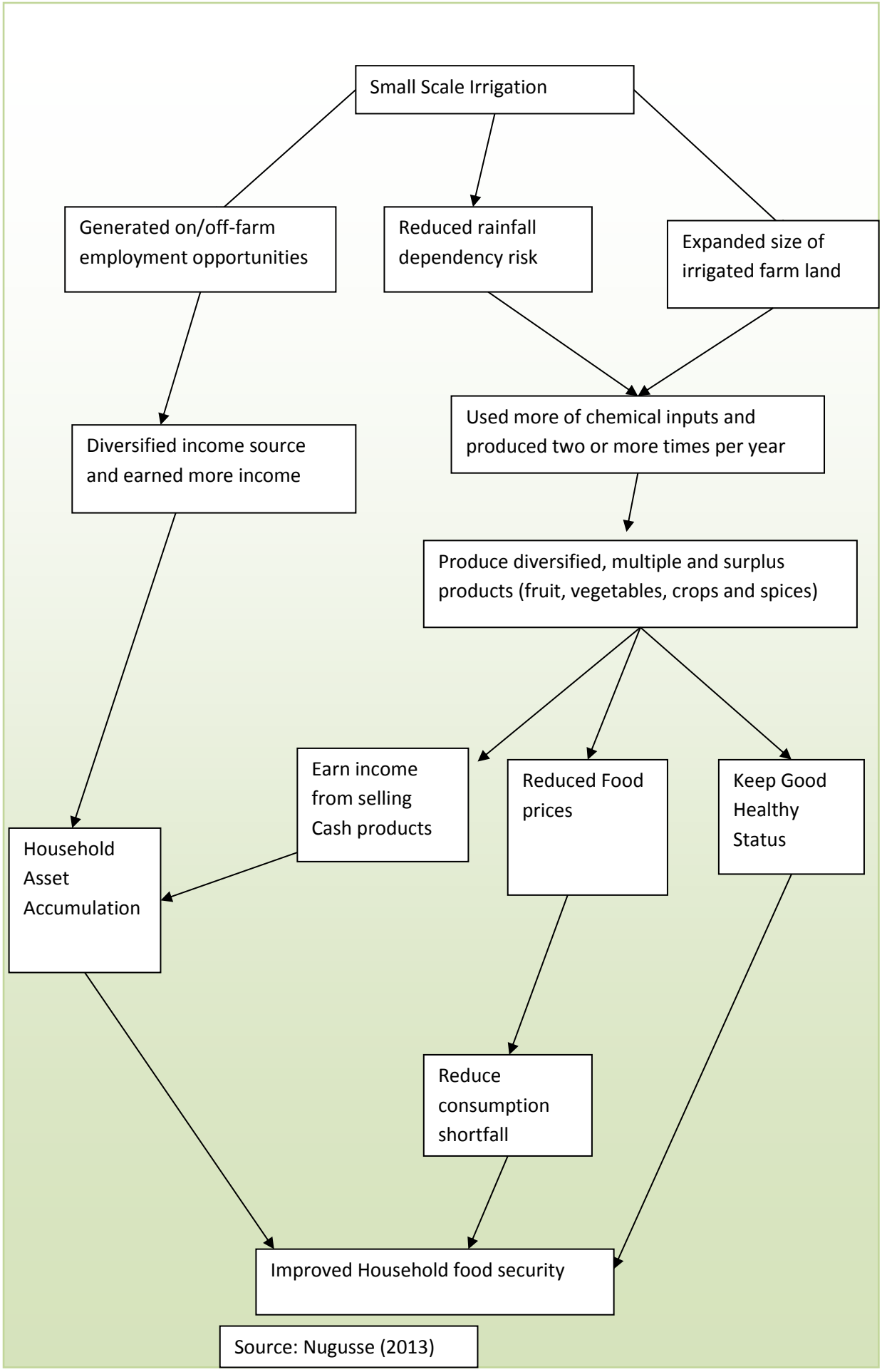


Figure 1: Irrigation food security linkage conceptual framework

2.3. Irrigation-poverty linkages

There are strong links between irrigation, agricultural productivity and poverty levels, reflecting both direct and indirect effects as described in Comprehensive Assessment of Water Management in Agriculture (2007). The direct effects of irrigation on yields and farm income are well understood. However, the feedback mechanisms and indirect effects that link irrigation and poverty reduction, as well as the effects of irrigation on inequality, are less clear, even though these secondary benefits may be more important in terms of poverty reduction Bhattarai et al. (2002).

As an important production resource in irrigated agriculture, irrigation water contributes to agricultural development and overall economic growth. Benefits of irrigation are realized through improvements in agricultural productivity and overall production, employment and wages, incomes, consumption, food security and other social impacts. These benefits tend to be interrelated and to reinforce the impacts of each other. With these benefits, irrigation water is linked to poverty alleviation both directly and indirectly. Direct impacts are realized through improved welfare of water users or agricultural producers having access to land, water and other production inputs household or micro pathway of the irrigation-poverty alleviation link. Indirect impacts are realized through expansion of economic activities in both agricultural and agriculture dependent nonagricultural sectors through backward and forward linkages resulting in improved economic growth, which contributes to poverty alleviation community or micro pathway and national or macro pathway of the water and poverty alleviation link Intizar eta al(2004)..

There is a plethora of literature on growth-promoting and poverty-reducing impacts of irrigation. No attempt is made here to review all the available literature. Hussain and Hanjra (2003) provide a very detailed review of recent studies on the subject. The review includes an empirical evidence based on comparisons of poverty with and without irrigation, and econometric evidence on the nature, direction and magnitude of impacts of irrigation on household income. The review covers assessments made at micro and macro levels.

The extensive review of past work on the subject suggests that there are strong linkages between irrigation, growth and poverty alleviation. The empirical evidence from the studies implies that irrigation has a strong land-augmenting contribution, with cropping intensity and overall crop productivity much higher in irrigated settings than in rain-fed

settings. In most situations, the value of crop production under irrigated settings is almost double that under rain-fed settings. This simply means that one hectare of land with irrigation produces a yield almost equivalent to that from two hectares of land with no irrigation. Providing adequate irrigation to a poor small farmer with one hectare of land would enable him to harvest as if she (he) has two hectares of land with no irrigation. Similarly, comparisons of labor employment per hectare and wages indicate that these are much higher in irrigated than in non-irrigated settings. Quantitative evidence shows that household income and consumption are much higher in irrigated settings than in rain-fed settings, and a 50 percent point gap is not uncommon Intizar et al (2004).

2.4 Importance of irrigation and understanding vulnerable livelihood in pastoralist and agro pastoralists in Ethiopia

2.4.1 The importance of irrigation for agro-pastoralists

In areas where rainfall is scarce or erratic, irrigation systems may add great value to cultivated lands. Globally, irrigated areas almost doubled over the past 50 years, from 161 million hectares (ha) in 1961 to 318 million ha in 2010 as stated in FAOSTAT (2013). Irrigation has been shown to have significant poverty-reduction and income-generation effects and was an important contributor to lowering real food prices from the 1970s through the 1990s Hussain and Hanjra (2003). In the SSA region, there was limited support to public irrigation investment and lower population density; thus, larger areas for agricultural expansion put less pressure on making land more productive.

However, the potential for expanding irrigated agriculture in SSA is significant. You et al (2010) estimated the large-scale irrigation potential at 15 million ha and a complementary small-scale component of 7 million ha and focusing on various smallholder technologies, estimated a total potential for motor pumps of 30 million ha, reaching up to 185 million rural beneficiaries across the region. However, although the potential of smallholder irrigation in the region is large, there are significant obstacles, including lack of public investment, to achieving the full potential Giordano et al (2012).

If SSA does not increase agricultural productivity through irrigation expansion and associated inputs, net food imports to the region will continue to increase as the population continues to rapidly grow. The medium variant of UN population projections indicates that the region will account for nearly half of all global population growth between 2010 and 2050. By 2050, more

than 20 percent of the global population will reside in SSA, and by 2100, every third person will be from SSA United Nations (2011). If the average economic growth of 5 percent achieved during 2003–09 ReSAKKS (2010) continues together with rapid population growth, pressure on food and natural resources will grow significantly, increasing demand for irrigated agriculture in its wake.

Irrigation interventions can transform the lives of agro-pastoralists and their communities through a number of pathways. All three dimensions of irrigation:-availability, access, and use have an impact on how agro-pastoralists are affected by irrigation interventions and thus on the success of irrigation development.

Smallholder irrigation systems are frequently used to grow vegetables and fruits during the dry season. Thus, they can directly provide enhanced food security and nutrition to farmers and other community members, due to greater availability and stability of food supplies during the dry season and crop diversification. Increased consumption of micronutrient-rich vegetables and fruits will also lead to positive health outcomes. Furthermore, irrigated areas are usually more labor intensive than rain fed areas, and therefore, demand for employment is likely to increase in irrigated communities, with positive contribution on the income of pastoralists. On the other hand, larger systems might be managed more intensively and might be better linked to larger markets, including international ones, and thus might indirectly lead to improved health and nutrition through higher incomes IFPRI (2013).

2.4.2 Understanding vulnerable livelihoods in Ethiopian pastoralist and agro-pastoralists

The arid and semiarid lowlands (ASAL) region of eastern Africa covers most of Djibouti, large areas of southern and eastern Ethiopia, the vast majority of Kenya, and virtually all of Somalia. Exact numbers on the size of populations in these regions are rather hard to come by, but the size of the pastoral population in the Horn of Africa has been estimated at between 12 million and 22 million people, depending on how pastoralism is defined and on data sources used Sandford (2010).

A study of the Somali region of Ethiopia by Devereux (2006) found that almost 70 percent of households engage in livestock rearing, but large shares also engage in cereal crop production (43.4 percent), firewood production (17 percent), and charcoal production (14.7 percent), while smaller but not insubstantial numbers of households engage in various cottage industries (for

example, mat making at 6.3 percent), petty trade or services, or higher value crop production. Salaried employment is present in just 3.2 percent of households.

Volatile prices (terms of trade) are one aspect of the vulnerability of pastoralist livelihoods. In addition to influencing prices, droughts and floods impact livestock mortality (particularly droughts). However, the fact that both external conditions (prices) and domestic conditions (price and livestock mortality rates) influence pastoralists' welfare means that one needs to look at droughts in both pastoralist and non-pastoralist regions of eastern Africa IFPRI(2012).

The data show several disturbing facts. First, there is some indication that droughts are increasing in frequency in recent decades (bearing in mind poorer recording of droughts in earlier periods). Certainly, the decade from 2000 to 2010 has been a very bad period for pastoralist areas, with four major droughts in all three countries. Second, the scale of impact is immense. In each drought bar the 2004 drought in Somalia more than a million people were affected in each country, and typically several million people. Third, major droughts in non-pastoralist areas of these countries, particularly Ethiopia, are also common and likely to impact pastoralist populations quite adversely if cereal prices rise. In 2003, for example, there was a major drought in the largely highland parts of Ethiopia that was estimated to have affected more than 12 million people. In landlocked countries like Ethiopia these kinds of shocks to non-pastoralist, cereal-producing areas could hurt pastoralists quite badly via, among other things, reduced demand for livestock and considerably higher grain prices IFPRI (2012).

Devereux (2006) found that droughts are the number one killer of livestock in pastoralist regions, by far and the main reason for decreasing livestock ownership in the Somali region of Ethiopia over the period 1995–2005. Mortality due to drought is cited in 100 percent of households for camels, cattle, and shoats (sheep or goats). According to a 2011 Ethiopian Central Statistical Agency (CSA) survey in the Afar region, 71 percent of households reported drought as the major shock, while more than 68 percent identified lack of drinking water and grazing land as having a moderate to severe effect on their livestock. The Pastoral Risk Management (PARIMA) project in southern Kenya and northern Ethiopia found a remarkably similar result, as do studies of the Ethiopian livestock sector as a whole Desta and Coppock (2004).

As a result the above reason views of some policy makers that pastoralism is not a viable livelihood and that some mix of rural and urban sedentarization is the right way to go.

A useful framework for thinking about these issues is one of economic transformation. Transformation is the process by which a traditional and largely subsistence agrarian economy becomes a more modern and diversified economy. There is a large literature on economic transformation going back to the founding fathers of economics, such as Adam Smith, Malthus, and Ricardo, but of greater relevance here is the more contemporary analysis of transformation episodes and of economic success stories in particular. In general, economists have identified four processes that interact with each other to produce a broader economic transformation Timmer (2007). The first one was Intersectoral transformations of output and employment. Agriculture's share of output and employment declines over time, although the former often declines more quickly than the latter. The second one was Intrasectoral transformation of agriculture. Agriculture is transformed from a traditional, subsistence, and low-productivity sector to a modern, commercialized, and higher productivity sector. The third one was A rural-to-urban transformation. The bulk of the population becomes urban, initially largely through migration from rural to urban areas. And the final one was Transformation of population structure. Specifically, a demographic transition from high birth and death rates to low ones occurs. Lower fertility rates are partly caused by other aspects of transformation (higher incomes and urbanization) but also by increased female education, improved health (such as lower child mortality rates), and family planning programs. These four processes invariably seem to accompany successful economic development, with many of the analyzed success stories either in contemporary Asia or in Western countries in the 19th and early 20th centuries. Headey et al (2010).

The basic calculus of this transformation process applies across countries which explains why these transformations are so prevalent but there will be many context-specific factors to consider when analyzing the implications of these processes for any given country or region, including pastoralist or ASAL regions IFPRI(2012).

2.5 contribution of Irrigation on the livelihood of agro-pastoralist

This section of literature review deals with socio-economic contribution of irrigation on agro-pastoralist livelihoods, contribution of irrigation on nutrition and health.

2.5.1 Socio-economic contribution of irrigation on agro-pastoralist

Given the high cost of irrigation development and the potentially high rewards, as well as the high possibility of failure, the assessment of irrigation potential must go beyond large scale versus small scale to integrate concerns regarding environmental sustainability, resource use efficiency, nutrition and health contribution, and women's empowerment IFPRI (2013).

The total beneficial contribution of irrigation development, both direct and indirect, can be summarized as Increased crop production (yield improvement) and increased farm income, Increased cropping intensity and crop diversification opportunities and the feasibility of year- round crop production activities, Increased farm employment more employment opportunities for agro-pastoralist families as well as for hired laborers in the locality, Increased farm consumption and increased permanent wealth (permanent asset accumulation due to irrigation). This has significant implications for reducing intrinsic food insecurity in a region, Reduced food (crop) prices allowing access to food for all, which is more beneficial to landless and subsistence families and provides better nutrition intake. This is also equally beneficial to urban poor and city dwellers, since they spend more than 50 percent of their daily income on food items, Reduced friction in the rural economy and reduced transaction costs including reduced farm marketing costs due to increased access to farm link roads and to other improved farm and non-farm related services in the region.

Multiple uses of water for bathing, washing, livestock and home gardens, Increased recharge of groundwater, easy access to groundwater and less drudgery for women in fetching water for daily household needs, Aesthetic and recreational benefits accrue out of irrigation facilities, Increased agro-pastoralist income (for farmers) and increased farm and off-farm employment opportunities for rural landless laborers result in better school attendance of children of farm laborers and improved social capital in society. This is due to the income effects of irrigation, since education is still a luxury compared to other basic needs: foods, clothes, shelter, health, etc., Export tax revenue accruing to government coffers.

The full benefits of irrigation are not only captured by agro-pastoralists, but are also spread to wider sections of society also called positive externality effects of irrigation access to society. These externality effects are the unintended income (also employment) equivalent of welfare changes brought about by the irrigation project.

All of these direct and indirect benefits achieved through irrigation access are difficult to quantify and value in monetary terms. Many of them are even harder to pin down and they also depend upon several other underlying institutional and structural factors and the benefits vary from system to system. This creates difficulties in identifying and delineating irrigation costs to the actual project beneficiaries or the service users. This high exclusion cost (costs to exclude members from service use once it is there) is the underlying factor for treating irrigation services as a typical public good type of resource. These indirect and intangible benefits have a large implication for management, and investment and financing decisions in the irrigation system. The level of complexity involved in identifying (and valuing) these intangible impacts of irrigation access and high exclusion costs prohibit private sector provision of the service, which are some of the reasons for societal involvement in provision of irrigation infrastructure almost everywhere in the world throughout history IWMI(2002).

2.5.2 Contribution of irrigation on nutrition

Food security is usually defined according to three dimensions that need to be fulfilled simultaneously and maintained over time: food availability, food access, and food utilization FAO (2008). Food availability refers to the existence of adequate food supply from domestic agriculture or food imports. Food access involves a household's ability to obtain food in the market or from other sources, which is usually determined by a household's income and the existence of markets. Finally, food utilization refers to the ability to consume nutritious foods and benefit from them Burney et al (2010). Irrigation schemes are likely to provide enhanced food security and nutrition to farmers due to a greater availability and stability of food supplies and crop diversification Molden (2007). Burney et al (2010) reported positive impacts of irrigation on food security among users of irrigated communal gardens in the Sudano -Sahel region. The consumption of vegetables during the dry season increased, and irrigators were 17 percent less likely to feel chronically food insecure Burney et al (2010).

Irrigation systems also have important impacts on the communities surrounding them, though studies measuring this outcome are scarce. Non-irrigators are likely to benefit from higher food availability and employment opportunities created by irrigation schemes Aseyehegn et al (2012) reported that 45 percent of the users of small-scale irrigation in Ethiopia faced labor shortages, whereas only 25 percent of the non-irrigators faced labor shortages for rain fed activities. In other words, irrigated land is more labor intensive and, therefore, increases hiring

opportunities. About 77 percent of irrigation users solved the labor shortage through hiring and 23 percent through labor exchange mechanisms.

2.5.3 Contribution of Irrigation on Health

Maternal and child under nutrition is responsible for 3.5 million deaths, 35 percent of the disease burden in children younger than 5 years, and 11 percent of total disability-adjusted life-years (DALYs) Black et al (2008). As a result of enhanced access to fresh vegetables and animal sources of food, irrigation systems can improve nutrition and health, particularly of children. Consumption of iron-rich foods, such as dark green leafy vegetables, can reduce incidences of anemia. Iron deficiency is a risk factor for maternal mortality and is responsible for 115,000 deaths and 0.4 percent of global total DALYs Black et al (2008). Vitamin A rich foods (such as orange-fleshed sweet potatoes, pumpkins, and so on) can reduce night blindness and susceptibility to illness. Deficiencies of vitamin A and zinc cause 0.6 million and 0.4 million deaths, respectively, and a combined 9 percent of global childhood DALYs Black et al (2008). Furthermore, access to greater quantities of nutritious food can reduce incidences of underweight and wasting. If children are exposed prenatally and during the first two years of life to a better diet, increases in height-for-age and reductions in the incidence of stunting are probable. Positive impacts of agricultural interventions in height-for-weight ratios, morbidity, and biochemical/clinical indicators, as a result of a more balanced diet, have been documented in previous studies Berti et al (2003).

Negative outcomes of irrigation on health may also result from the increased use of complementary inputs, such as pesticides, fertilizers, and other chemical products, due to the higher-input intensity of irrigated agriculture. However, the number of studies addressing this issue is still limited. Pesticides may cause acute poisoning through intentional or accidental exposure and through long-term exposure for instance, through the ingestion of pesticide residues on food and drinking water IFPRI (2013).

2.5.4 Contribution of irrigation on income

The existing literature in relation to the contribution of irrigation on poverty is mixed. Some studies indicate the contribution of irrigation on agricultural productivity and agro-pastoral livelihood is not significant. But others have confirmed a strong link between irrigation and poverty reduction in developing countries.

Another study by Hanjra et al. (2009) in SNNPR found that although irrigation contributes to poverty reduction, smallholders remain poor due to small land holdings, large family size, high dependence on agriculture, illiteracy, low education, poor health, poor access to infrastructure and markets, and low use of modern inputs such as fertilizer.

On the other hand, many studies have indicated irrigation is positively correlated with household income and expenditure and negatively correlated with poverty. These studies have confirmed that the probability of households with access to irrigation water being poor was significantly less than those with no access to irrigation water.

Some of the studies undertaken in Ethiopia in relation to the role of small scale irrigation in poverty reduction are summarized below. Another study by Gebregziabher et al, (2009) in Tigray indicated that farming income was more important to agro-pastoralists than to pastoralist households, while off-farm income was negatively related with access to irrigation. They also found that irrigating households‟ average income was above the regional average, while non-irrigating households‟ average income was 50 % less than the average income of irrigating households.

Similarly, Haile (2008) studied the contribution of irrigation development on poverty reduction and he concluded that households‟ access to deep well or shallow well irrigation has a significant impact on poverty reduction through increasing household incomes and consumption and overall family employment. The study also showed access to deep well or shallow well irrigation has a significant effect in increasing the welfare of beneficiary households. However, the study has indicated that irrigation through pond water had not significant effect in increasing the welfare of beneficiary households.

A recent study by Haji and Aman (2013) revealed that access to small-scale irrigation scheme have significantly reduced the incidence, the depth and the severity of households‟ poverty in Gorogutu District of Eastern Hararghe. Their empirical model revealed that access to irrigation scheme has significantly influenced households‟ consumption expenditure level. They indicated that the per capita consumption expenditure of irrigation users is 25% more than non-users of irrigation. In general their study concluded access to small-scale irrigation scheme improved the livelihood of households in the study district.

Similarly, literature from other parts of the world show mixed results. In India, for example, Bhattari et al. (2002) discovered that access to irrigation infrastructure along with the

availability and access to new technologies, high yielding varieties and fertilizers were the principal factors for the success of the green revolution in the country. They noted that better access to irrigation has facilitated better cropping practices and contributed to modernization of the agricultural sector. Huang et al (2005), a study from China which showed that irrigation increased income and reduced poverty and inequality in the country.

2.6 Water and Irrigation in Ethiopia

The agricultural potential of Ethiopia is largely unexploited; with less than 40 percent of the arable land currently under cultivation. Under the prevalent rain-fed agricultural production regime, the progressive degradation of the natural resource base, especially in highly vulnerable areas of the highlands, aggravates the incidence of poverty and food insecurity in these areas. Rural dwellers in the country are among the most vulnerable to poverty, with limited access to agricultural technology, limited possibility to diversify agricultural production, underdeveloped rural infrastructure, and weak or sometimes lack of access to agricultural markets and to technological innovations. These issues combine with increasing degradation of the natural resource base, especially in highlands, to aggravate the incidence of poverty and food insecurity in rural areas IWMI (2005).

The 12 river basins covered by Ethiopia have an annual runoff volume of 122 billion m^3 of water. There is also an estimated 2.6 billion m^3 of ground water potential MoWR (2002). This amounts to an estimated 2,620 m^3 of water per person per year in 1990 for a population of 47 million. By 2005, this has reduced to 1707m^3 due to population growth to about 73 million and the per capita availability continues to fall. Ethiopia will become a physically water scarce country by the year 2020. Furthermore, 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. Crop failures due to dry spells and droughts are frequent. Moreover, there is significant erosion, reducing the productivity of farmland IWMI (2005).

Irrigation is one means by which agricultural production can be increased to meet the growing food demands in Ethiopia. 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 (number of crops per year). 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 rains 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.

The estimates of the irrigation potential of Ethiopia vary from one source to the other, due to lack of standard or agreed criteria for estimating irrigation potential in the country. The earlier reports, for example the World Bank (1973) as cited in Rahmato (1999), show the irrigation potential at a lowest of 1.0 and 1.5 million hectares, and a highest of 5.3 million hectares, according to Tilahun and Paulos (2004). Thus, the above variation in estimates calls for an accurate review of the irrigation potential of the country.

Similarly, there is no consistent inventory with regard to the developed irrigation of the country. Based on data from IWMI (2007) and grey documents from MoWR and MoARD our estimate of 640,000 hectares of irrigation nationwide includes 128,000 ha from RWH, 383,000 ha from SSI and 129,000 ha MSI/LSI. This means that a significant portion of cultivated land in Ethiopia is currently not irrigated. This section examines Ethiopia's water sources for irrigation, current irrigation schemes, and potential to increase irrigated lands. Ethiopia has surface water, groundwater, and rainwater sources that can be developed for at least 5.3 million hectares of irrigation potential. This means that up to one-sixth of the country's cultivable land can be irrigated through existing water sources – a significant increase from current levels. This includes 3.7 Mha from gravity-fed surface water and an additional 1.1 and 0.5 Mha from groundwater and rainwater harvesting, respectively.

In analyzing the opportunities for expanding small-scale irrigation in Ethiopia, IWMI (2005) summaries the difficulties as follows: '… even in countries where water resources potential is relatively well known and known to be substantial, other conditions may not be conducive for sustainable irrigation development to achieve food security, improve livelihoods and reduce poverty. Such conditions may vary from attributes such as topography, soils conditions and rainfall characteristics, to technical and socioeconomic issues such as lack of physical infrastructure, access to innovations and information, markets, credits, extension, and other institutional support services needed to enhance viable irrigation farming. There is ample evidence that most of these conditions have not been sufficiently met in the expansion of small-scale irrigation, micro irrigation and rainwater harvesting in Ethiopia. Thus, the impacts of these initiatives in most regions of the country have been limited, especially in addressing the country's chronic food insecurity problems IWWI (2007).

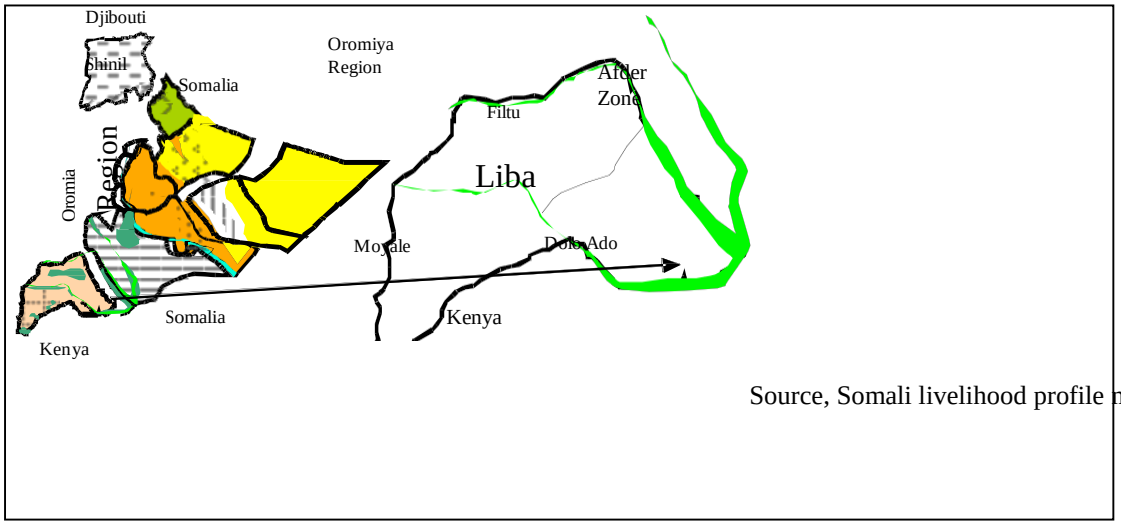
3. RESEARCH METHDOLOGY AND PROCESSES

3.1 Selection of the study Area

The research study conducted in Dolo Ado and Dolo Bay woredas, Liben Zone of the Somali Regional State. Dolo Ado and Dolo Bay woredas located at about 1000 KM south-East of Addis Ababa. Dolo Ado woredas has 28 village Administrations, from these villages 4 of them are agro-pastoralist and located around the coast of the rivers and they have 756 HHs, from which 120 HHs were practicing irrigation and the rest are not practicing irrigation that means they are pastoralist even if they are living around the river basin. Dolo Ado has population of 92,132 and Dolo Bay has population 22,803 which lives around Genale-Dawa livelihood zone according to census 2007. Similar to Dolo Ado woreda, Dolo Bay also located in Genale –dawa livelihood zone of Somali regional state, however, Dolo Bay woreda share mainly from Genale River. Dolo Bay has 17 villages and from these villages 3 of them is located around Genale river basin and which have 470 HHs and from which around 90 HHs were agro-pastoralist and the rests are far from the river coast and not practicing irrigation. The major means of livelihood of the people in Dolo Bay like Dolo Ado woreda is pure pastoralism and agro-pastoralism. Livestock husbandry contributes the lion's share to the livelihood of the people and farming is the next for both woredas. The role of other means of livelihood such as trade is also growing in the area.

The reasons for selecting the study area are first the study areas are located in Genale –Dawa livelihood zone and which are an agro-pastoralist activities are ongoing, Second better irrigation activities are practicing as a result of government and NGO intervention to improve the income of the households and third no detail studies conducted in the area related to irrigation practices and both woredas are the operation area of my current organization.

Figure 3:Map of Genale-Dawa Riverine Livelihood Zone



Source, Somali livelihood profile modified 2008

3.2 Sampling techniques

In this study, a multi-stage random sampling procedure was applied for the selection of sample respondents. In the first stage we stratified the Genale-Dawa livelihood zone into Genale and Dawa River. In the second stage we applied simple random sampling to draw one village from Dawa River and one village from Genale river basin and then totally we had two sampled villages from seven villages which have access to irrigation in Dolo Ado and Dolo Bay woredas from Genale –dawa livelihood zone.

In the third stage, the total households in the two villages were stratifying into two strata: agro-pastoralists and pastoralist households. In the fourth stage we applied systematic random sampling method to draw each sample households from the sample frame of agro-pastoralists (irrigation users) and pastoralists list. The sample frame had two lists such as agro-pastoralists and pastoralist households. The pastoralists also selected within villages of agro-pastoralists to minimize the problem of heterogeneity factors except irrigation practices. Then, the lists of agro-pastoralists and pastoralist households in these villages were obtained from woreda office of Woreda Livestock Crop and Rural Development Office. Moreover the lists of the pastoralists and agro-pastoralist households were verified by village's chairperson and development agent at village level.

For this study due to large number of pastoralist households relative to agro-pastoralists in the villages 66 households from all group selected through using simple systematic random sampling. The *household* was used as the basic survey unit for the analysis. A household was defined as a number of people living and eating together in the same dwelling and share the same income. For the study we were used structured and semi structured questionnaires. The questionnaires were focus on Household demographic characteristics, Land utilization, Crop production with irrigation, Livestock production, Credit, input and extension service supports in production and off-farm income.

3.3 Source of Data and methods of data collection

The sources of data for this study were mainly based on primary and secondary data. Secondary data were collected from, literatures, books, internet, Woreda livestock Crop and rural development office and reports of various governmental and non-governmental organizations. The Primary data were collected through developing semi- structured and structured questionnaires, key informant interviewing, observations and focus group discussions.

The structured questionnaires' were developed for interviewing sample households who were living in the study area. The key informant questionnaires were developed for interviewing influential people living in the study areas, such as village leaders, district officials, elders and religious leaders and irrigation user group leaders. On this side 10 key informant interview were made for this study.

The FGD discussions were focused totally on the factors which were influencing the development of irrigations in the study area. The participants of the FGD groups were selected from agro-pastoralists and pastoralist groups. Totally we did 4 FGD discussions, 2 FGD discussion for each sampled village, One FGD discussion for agro-pastoralists and one for pastoralists.

Moreover, physical observations were applied during field trip. During this we tried to observe what they are producing, progress, challenges and different issues were assessed for the purpose of the study.

Generally we applied both qualitative and quantitative data collection tools, Quantitative methods were consist of structured questionnaires and compiling data regarding the main areas of inquiry for this study analysis. The qualitative approaches were included in-depth and key informant interviews as well as focus group discussions and observations with semi-structured questionnaires. The quantitative and qualitative instruments' implementations were informed to data collectors in details during preparation and data collection period.

For the data collection six enumerators were recruited from the study area and necessary care were taken in recruiting the enumerators and strict supervision were done during the course of survey work. The enumerators were fluent speaker of the local language and English. They were gain intensive training on the data collection procedures, interviewing techniques and the detail content of the questionnaires.

3.4 Research Design and Method of Data Analysis

To achieve its objective, this study used descriptive statistical analysis. The descriptive was used to compare the livelihood of agro-pastoralist and pastoralist households though using frequencies, means and maximum and minimum values of some important variables to analysis the impact of irrigation on agro-pastoralist and pastoralists.

Moreover, basic statistical tests such as the t-tests, standard deviation and percentages were used. Statistical Package for Social Science (SPSS) was applied for the empirical analysis. Focus group discussions and key informant interviews were employed to provide key information on the key challenges to enhancing the benefits from irrigation.

4. RESULTS AND DISCUSION

4.1 DESCRIPTION OF THE STUDY AREA

4.1 Livelihood of the study Area and Somali Region

Although lowland areas are often perceived as arid regions with no potential for agriculture, this perception is almost always inaccurate. In many pastoralist areas, livestock rearers co-exist with farmers, and are often cultivating crops themselves. It is not surprising, therefore, that Somali region supports a diversity of livestock-based, crop-based and mixed (agro-pastoral) livelihood systems. The region has many seasonal rivers that allow riverine farming, there are irrigation schemes, and in some districts rainfall is adequate to support rain-fed farming.

There two districts rainfall patterns in somali region, which define two dominant farming systems. Riverine farming is practiced along the banks of the perennial rivers, the Shabelle and Dawa/Genale in central and southern Somali region. These low-lying areas, the long rains (Gu) fall from April to June, and this also the planting season. The short rains (Deyr) fall between October and December, but are considered unreliable by agro-pastoralist. Since total rainfall is inadequate lengthy enough to allow the cultivation of crops, even long-maturing varieties. Rain fed agriculture is practiced by Somalis on the Jigiiga plains, farming methods are similar to those in the Ethiopian highlands, smallholders use family labor and cultivate with oxen and ploughs. A third farming system found in Somali region could be described as opportunistic agriculture , which exploits niches within pastoralist areas, such as along seasonal river beds or in valley bottoms that retain moisture after the rains. Furrows and channels are used to harvest rainwater; much of this farming is practiced by pastoralists as a secondary activity that yields modest harvests in most years and significant harvests only occasionally.

Apart from large-scale irrigated agricultural schemes, farming in Somali region can be described as "low input, low output" agriculture .Ox-ploughs are used, but there is no irrigation technology on family farms. Farmers dig furrows (called mangat or moos) to channel water from rivers or ponds to their plots. In Dolo Ado and Dolo Bay, erratic rainfall is described as the main problem that agro-pastoralists face and they are practicing irrigation pumps from riverine.

The Somali Regional State is known to have an estimated land potential for irrigation of 600,000 hectares along the banks of four perennial rivers and a number of seasonal streams. At present, much of the irrigation potential (in terms of irrigable land availability) is underutilized. This is not an accident, but future development will require careful attention due to other contextual factors, including land- ownership, environmental protection, flood management, and upstream/downstream relations. There are also technological constraints and conflict-affected areas to consider. There are major plans to scale up irrigation in the Somali region. The Ministry of Agriculture estimates that close to 850,000 hectares of land could be irrigated (an estimate that seems optimistic), and there are already significant projects under way as reported by Flintan (2011).

In Somali, Sedentary farming is the second-largest livelihood. For example, Devereux (2006) found that almost half of all households were engaged in some type of crop production. Moreover, there is substantial evidence that pastoralists have been rapidly moving out of pure pastoralism and into agro pastoralism. However, to date, this diversification has not been a positive transformation process because most such households have been pushed out of pastoralism by a combination of shocks (droughts, disease outbreaks) and stresses (population growth, grazing land encroachment), rather than pulled out by more remunerative non-pastoralist opportunities. This is evident from the fact that agro pastoralists are generally substantially poorer than specialized pastoralists. Outside of irrigation, sedentary farming in these environments is low input–low output, and just as vulnerable to drought (and flooding) as pastoralism.

The wording of the constitutional clauses pertaining to farmers and pastoralists is remarkably similar, but the reality has been quite different. Despite the ultimate control of

land by the state, the gradual codification of land rights has improved the tenure security for farmers who pay land tax and now can often register their use rights. In contrast, the land rights of Ethiopian pastoralists have become less secure over time. Specific laws to implement pastoral land rights have not been developed…. Recent appropriation of communal pastoral grazing land for large-scale irrigation schemes, private ranches, and commercial enterprises seems to lack participation, and is at odds with promoting livestock production and trade.

Large-scale irrigation projects planned for the Somali Region include the three Ethio-Italian irrigation projects in the Jijiga agro-pastoral area (Chinaksen, Biyo, and Elbahe), although they failed to be realized. Poor design and lack of clear land tenure policy at the time leading to the project being caught up in land tenure-related conflicts were implicated in the failure of the Jijiga dam and irrigation scheme. The local pastoral community demonstrated their displeasure with the project by breaking everything that was breakable and carrying away stones in the sluice-way; these stones are useful for other purposes.

Farming occurs along riverbanks and in river valleys, and is dominated by Bantu Somalis. Low input methods are used, including human labor, hand-hoes and traditional irrigation methods such as furrows and channels, through mechanical pumps are used to divert river water to some fields. After the harvest, during the hot dry Jilala season (January to March), there is little agricultural activity and farmers consume their harvests. Currently government and non-governmental organization especially Productive Safety Net Program is trying to develop small scale irrigation canals around Genale-Dawa river basin at Dolo Ado Dolo Bay districts.

4.2 A socio-economic profile of Somali region

The Somali National Regional State of Ethiopia covers almost a third of Ethiopia's land area, and much of it is semi-arid. The Region is home to some five million people, of whom about 60% are practice pastoralism according to Seid (2012). About 15% are sedentary, riverine farmers and the rest practice different forms of agro-pastoralism. The

altitude of the Region varies between 200 and 2,000 meters above mean sea level; mean annual rainfall is between 150 to 660 mm a year. The low annual rainfall and its uneven distribution, together with the frequent recurrence of drought, have made water the single most important element that determines the living style of the population. People, together with their herds of camels, goats, sheep, and cattle, move from place to place, continuously, in search of water and grazing.

Precipitation in the overall Somali Region, based on available daily rainfall measurement data from 1980–2009 as provided by the Ethiopia Meteorological Authority, averages 390 mm, with significant differences between the dry south and east and the wetter north. As the provided time series includes considerable gaps, the real annual rainfall can be considered as closer to values, as given in literature, of 500 mm. Strong inter-annual variations lead to periodic floods and droughts. Potential evapo-transpiration is estimated with 1,500–2,500 mm/year as stated in Muchiri (2007), resulting in an overall negative water budget.

4.3 Contribution to national economies

The livestock sector represents 10% to 15% of agricultural GDP across Ethiopia, and a significant portion of the countries' livestock is found in pastoral areas. However, national accounts are incomplete

In Somali region only, it is estimated that the actual value of cross-border livestock sales is three to six times that given in official figures for the whole country.

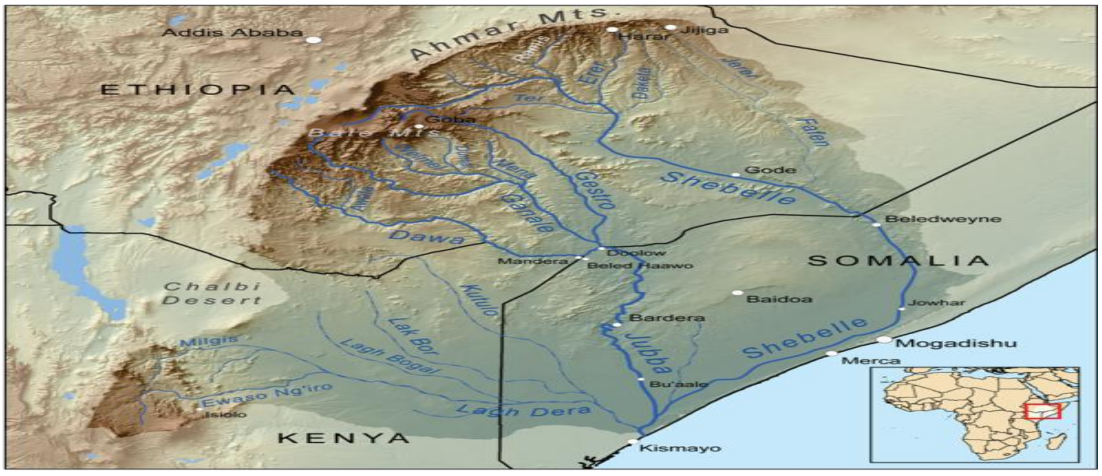
4.4. Major river basin of the region

SHAAC (2008) identifies the key basins within SRSE as the following: Wabi Shebelle River Basin, which comprises the drainage of the seasonal rivers of Fafan, Jerar and Dakhato. This is the largest basin, with an elevation ranging from 2,000m to 200m above sea level, sloping towards the Wabi Shebelle River. The entire Shabelle and Nogob zones and parts of Fafan, Jarar, Koreha, and Afder Zones lie in this basin (SHAAC 2008)).

Genale-Dawa-Web River Basin (Juba Basin), which comprises three major river drainage systems. The elevation of the basin ranges from 150m to 1,600 m above sea level, and the entire basin slopes southwards. The entire Liban Zone and part of Afder Zone lie in this basin. North-eastern-Warder drainage Basin, which comprises most of Dolo Zone, parts of Fafan and Jarar Zones. This Basin is characterized by a plain with a gentle slope draining towards Somalia, and on to the Indian Ocean (MoWE 2007).

Awash Basin - This comprises the drainage areas of several seasonal rivers in Siti Zone. The drainage system is easterly, towards the Awash River.

Figure 2:Major Drainage Areas of the Somali Region



Source: Kmusser [CC-BY-SA-3.0(http://creativecommons.org/licenses/by-sa/3.0)],via

Wikimedia Commonas.

4.5 Socio-Economic Profile of the study area

Genale Dawa river basin has an area of 171,042 Km^2, covering parts of Oromia, SSNRP, and Somali regions. It is the third largest river basin, after Wabi Shebelle and Abbay river basins. The river basin has a lowest elevation of 171 m and a highest elevation of 4385 m. The total mean annual flow from the river basins is estimated at about 5.8 BMC. The basin falls mainly in the arid and semi-arid zone and is generally drought-prone with erratic rainfall (MoWR 2007).

About 85 irrigation potential sites are identified in the basin, out of which, 18 are small-scale, 28 are medium-scale, and 39 are large-scale. The basin has an estimated total potential of 1,074,720 hectares of irrigable area. Out of these, a potential 1805 hectares are for small-scale, 28,415 hectares for medium-scale and 1,044,500 hectares for large-scale development (MoWR 2007).

Dolo Ado and Dolo Bay woredas are also located in this livelihood zone and Dolo Ado has 4 villages which are agro-pastoralist from Genale and Dawa River basin from the total of 28 villages. However, in Dolo Bay 3 villages are agro-pastoralists around Genale River from total of 17 villages (Somali livelihood profile 2013).

The area is predominantly lowland in Somali region except for small hills around Suftu and the altitude increases towards Filtu district. Temperature range 35°C - 40°C and annual rainfall less than 200mm. the Soil types of these area is sandy in pastoral areas, loam by rivers. Drought-resistant bushes and acacia are availing in the pastoral areas, fruit trees and toothbrush tree along rivers (Somali livelihood profile 2013).

The Ganale River (permanent) and the Dawa River (seasonal) merge near Dollo Ado to form the Juba River. There are also seasonal underground streams suitable for flood-recessional farming. Shoats and cattle's grazing is predominant livelihood of the area especially in the pastoralist area and small scale irrigation also practicing around Genale and Dawa River basin. Irrigated land currently extends 144km along the Dawa and 80km along the Ganale Rivers. Vegetables and fruit are grown mainly as cash crops (tomato, onion, banana, papaya and mango). Land ownership is important in this area and only areas unsuitable for cultivation or irrigation are un-owned or unoccupied. Main risks relate to pump irrigation are access to fuel or pump breakdown. Droughts can be weathered with irrigation. Better-off households can minimize risks by storing their harvest; pump-owners spread the risk by having pumps in both rivers (MoWR 2007).

4.6 Demographic characteristics of the study area

In this section, demographic characteristics of the sample households such age, sex, family size, education level of household head and number of Adult labor were analyzed.

4.6.1 Family Size, Family labor and Dependency ratio

In this study the sample were considered 33 agro-pastoralist and 33 pastoralist households. For these sample households, family size is useful for formulating various development plans and for monitoring and evaluating their day to day implementation activities. Average family size at the national level in Ethiopia was 4.7 (CSA, 2007). In this study area, the average family size was 7.62 with a minimum 2 and maximum of 17. The t-test shows that there is significant difference in family size between agro-pastoralist and pastoralist households at a 1% level of significance (Table 1).

Table 1:Family size, Labor force and dependency ratio for agro-pastoralist and pastoralist households

Characteristics	Agro-pastoralist Households (N=33)	Pastoralist households(N=33)	Total Households(N=66)	t-value for difference
	(Mean)	(Mean)	(mean)	
Family size in numbers	8.06	7.18	7.62	.965**
Family size in Adult Equivalent (working force)	6.49	5.62	6.02	.288*

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Note: **significant at 1%, *significant at 10%, ***significant at 5% probability of significance level

In rural Ethiopia, household family is the main source of labor for all income sources. Family size in adult equivalents indicates the sample households" average family labor force for agricultural production and other income-generating activities. The average family size in adult equivalents in the study area was 6.02 with a minimum 2 and maximum of 13. The t-test shows that there is significant difference between agro-pastoralist and pastoralist households at 10% level of significant (Table 1). Thus, agro-pastoralist households have owned better labor input than pastoralist households to implement their different livelihood activities in terms of average family size in adult equivalent in the study area when we compare both.

The dependency ratio shows the ratio of economically inactive compared to economically active members of a household. Economically active members of a household, whose age is from 15 to 64, are assumed to be the principal sources of income for the household. Household members under 15 and over 65 are assumed to be economically inactive and dependent on economically active members of a household for education, clothing and health care (Getahun, 2011). The dependency ratio of agricultural households provides planners and policy makers with an indication of agricultural labor availability in male- and female-managed holdings and their abilities to actively participate in agricultural programs and projects. Members of holdings with high dependency ratios might not be able to participate in programs and projects due to time, labor and/or financial constraints, that is, dependency ratio is thought to be negatively related to income of households (FAO, 2010). In the study area, the average dependency ratio was 144.78 %, which means every 100 economically active persons had 144.78 extra persons to feed, clothe, educate and medicate. This can have important implications for poverty alleviation efforts. No statistically significant difference was observed between agro-pastoralist and pastoralist households for the dependency ratio (Table 1).

4.6.2 Sex and education of the household head

In the study area, the head of the household generally is responsible for the co- ordination of the household activities. As such it is relevant to examine attributes such as sex and education of the head as one component of irrigation participation decisions. Of the 66

sampled households, about 71.2 % were male-headed. The percentage of pastoralist female household heads were more than agro-pastoralists (Table2). Economic growth is driven by change in people's capabilities or their human capital, as affected particularly by their education. Educated people can more easily contribute to the generation of new technologies and more readily utilize those technologies. It is one of the main factors affecting adoption of irrigation technologies to improve agricultural productivity (Maddison et al., 1970). The education level of household heads is higher for agro-pastoralist households than pastoralist households (Table 2). In the study area 81.8% of agro-pastoralist households are able to read and write, where as 66.7 % of pastoralists households cannot read and write (Illiterate).

Table 2:Household member, gender and education and characteristic(%)

Characteristics	Agro-pastoralist household(No.=33)	Pastoralist households (No.=33)	Total households(No.= 66)
Household head gender			
Male	90.9%	51.5%	71.2%
Female	9.1%	48.5%	28.8%
Total	100%	100%	100%
Household head education			
Illiterate	18.2%	66.7%	42.4%
Read and Write	81.8%	33.3%	57.6%
Total	100%	100%	100%
Age of the HH head	41.3(mean)	38.8(mean)	40(mean)

The average age of the household heads in the study area was 40 years with a minimum of 18 and maximum of 77 years. The age of the household head influences whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. There is significant difference in the distribution of household head age of the sampled households between agro-pastoralist and pastoralist household heads especially age from 46-64 years. Agro-pastoralist households were 36.4% under this age and pastoralist households were 9.1% (Table 2)

4.7 Land Holding

Land is the major productive asset in agrarian countries like Ethiopia. Cultivated land appears to be the most important scarce factor of production. In the study area, own land was used for cultivation, however, the agro-pastoralists do not have legal certificate for the land owned. They possessed the land by themselves without government intervention on certifying the land they currently had. The average land holding size of the sample agro-pastoralist households in the study area is 1.54 ha, which is comparable to the national land holding of 1.0 hectares (Getahun, 2011). There is significant difference between agro-pastoralist and pastoralist households in land holding, because the study shows that pastoralist households do not have land and moreover, the households have not cultivated any land even rented in or rented out even if they are living on the same village. These households livelihood is depend on livestock rearing rather than crop production. However, if pastoralist households want to irrigate they can cultivate non occupied land and the government also encourage them to farm and it can provide them land freely in group or in private.

This study did not examine the grazing land of the area however, most of the grazing area owned by communal and some belongs to private.

Table 3:Land holding and utilized

Characteristics	Agro-pastoralist Households (No.=33)	Pastoralist Households (No.=33)	Total Households (No.=66)	t-value for difference
Total land owned	3.08	0	1.54	.891**
Total land utilized	2.20	0	1.10	-.728**
Land rent in	0	0	0	
Land rent out	0	0	0	

**. Correlation is significant at the 0.01 level (2-tailed).

In Ethiopia land is a public property. Sale of land is not allowed, but land rental and sharing through agreement between users. However, in the study area the study shows there is no land rent practices.

Figure 4: Irrigation canals which not properly utilized by agro-pastoralists

4.8 Types of Houses

Types of housing are an indicator of improving the well-being of agro-pastoralists. In rural agro pastoralists and pastoralists of Ethiopia most of the houses are grass-roofed and temporary due to the climate conditions but wealthier households have a corrugated iron roof. A higher percentage of agro-pastoralist households from the sample had corrugated iron roofed houses than pastoralist households.

Table 4: Types of houses holding

Housing Type	Agro-pastoralist Households	Pastoralist Households	Total
	Percent	Percent	Percent
Grass roof	81.8	93.9	87.9
Corrugated roof	15.2	6.1	10.6
Both Grass and corrugated roof	3	0	1.5
Total	100	100	100

4.9 Major crops and vegetable grown using irrigation by agro-pastoralists

Dominant crops and vegetable grown with irrigation in the study area are maize, onion, tomato, mango, Banana, pepper, lemon and cabbage. In the study area there is no rain fed crop or vegetable production because the rain fall is below normal. Only agro-pastoralist households cultivate crops and vegetable using water for irrigation from Genale and Gawa rivers. In the study area only river water is source for irrigation practice. As a result access to irrigation has been regarded as a powerful factor that provides a greater opportunity for multiple cropping and vegetable productions in the area. Households who have access irrigation from the rivers are cultivating both permanent and short season products twice a year; these farmers are agro-pastoralist because they are practicing both crop and livestock

production. The most common field crops (cereals) produced by irrigation is maize whereas the most commonly produced irrigated vegetables are onion, tomato, banana, Papaya, lemon, cabbage, mango and pepper (Table 5).

Table 5: The major field crops and vegetables grown using irrigation(%) by Agro-pastoralists

Crop types	Number of Agro-pastoralist responded from total 33 households	Percentage of agro-pastoralist households growing crops and vegetables from total interviewed agro-pastoralist households
Cereals		
Maize	31	93.9
Vegetable and Fruits		
Onion	8	24.2
Mango	3	9.1
Tomato	18	54.5
Banana	15	45.5
Pepper	4	12.1
Lemon	7	21.1
Cabbage	4	12.1
Others	1	3

In field crop (cereal) cultivation using small-scale irrigation, maize was the dominant. It is grown by 93.9 percent of agro-pastoralist sample households. Tomato, Banana and onion are the second, third and fourth major field crops, grown by 54.5%, 45.5% and 24.2% respondents respectively (Table 5). Vegetables were the more commonly produced crops with small-scale irrigation systems. The most frequently grown crop was tomato; tomato needs small amount of water and better demand in the market, but requires follow up with

pesticides. Onion and Banana also another vegetable commonly produced in the area. Cereal crops grown using small-scale irrigation were few in number in the study area because of the aridness of the area. However the agro-pastoralist households stated different reasons why they are grown only few. The major factors for production decision were good production (84.8 %), easier to cultivate (60.6%), better price (54.8 %,), high disease tolerance (33.3%), drought resistance (15.2%) and seed availability (9.1) respectively (table 6).

Table 6:Reason for selecting the major crops and vegetables for irrigation

Reasons	Numbers of Agro-pastoralist responded from total 33 households	Percent of Agro-pastoralist households responding from total 33 households
Better price	18	54.5
Good production	28	84.8
High disease tolerances	11	33.3
Easy to cultivation	20	60.6
Seed availability	3	9.1
Drought resistance	5	15.2

Figure 5:Irrigation products at Fikow and Dasheg kebele from left to right side respectively

4.10 Agro-pastoralist and pastoralist Households gross Income comparison

4.10.1 Cropping and vegetable Incomes from irrigation by ETB

Total cropping income is the amount of mean annual income of a household obtained from both types of cropping systems cereal and vegetable irrigation. The mean annual income of a household from cropping income in the sample livelihood zone was ETB 27,792.42 (Table 6).when the total annual cropping income of agro-pastoralist household was considerably significant however; pastoralist households do not have any income from small scale irrigation because the study shows that pastoralist households do not utilize and use any size of land for crop production.

The t-test shows that there is a significant difference between agro-pastoralist and pastoralist households at 5% level of significance (Table 7). This suggests that irrigation markedly increases agro-pastoralist households income and in the reverse pastoralist households income negatively related with irrigation practices.

Table 7:Income from irrigated crop and vegetable production in ETB

Characteristics	Agro-pastoralist Households (N=33)	Pastoralist Households(N=33)	Total households (N=66)	t-value for difference
Annual average income from different crops production	21,987.88	0.0	10,993.94	.963**
Average Annual income from vegetable and fruits	33,596.97	0.0	16,798.48	.988**
Total cropping income	55,584.85	0.0	27,792.42	-.281*

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 8:Income from irrigated crop production in ETB

Variables	Respondent Woreda	Respondant Kebele	N	Mean	Std. Deviation	Std. Error Mean
Annual income from different crop production	Dolo Ado	Fikow	30	16,916.67	55,228.379	10,083.276
	Dolo Bay	Dasheg	36	6,058.33	7,205.330	1,200.888
Annual income from different Vegetable and Fruit	Dolo Ado	Fikow	30	26,266.67	93,517.169	17,073.821
	Dolo Bay	Dasheg	36	8,908.33	16,780.488	2,796.748
Annual income from Vegetable and crops	Dolo Ado	Fikow	30	43,183.33	146,029.607	26,661.237
	Dolo Bay	Dasheg	36	14,966.67	20,819.236	3,469.873

The kebele with higher mean income from irrigated crop production was Fikow. This kebele use both concrete line irrigation and soil fenced irrigation canal from Dawa River. Moreover, this kebele has relatively better local market place than Dasheg kebele. Moreover they have

strong water use associations. The association has multiple purposes; some of them were to avoid conflicts, used as a source of market information, supply farm inputs for member households, protect and amend river diversion canal when damaged and hiring guard for motor pump. Thus, this kebele has better irrigation water use system and can earn better income from irrigation farming. However, in this kebele agro-pastoralist faces water shortage from 1-3 months due to the seasonal nature of Dawa River.

Dasheg kebele located around Genale river and they do not face water shortage throughout the year like Fikow, however when we compare the mean income of crop and vegetable with Fikow kebele, it is lower because of less market availability for their product and moreover mostly they are using soil fenced irrigation canal which consume more petrol than that of concrete canal irrigations.

Figure 6:Concrete line and soil fenced irrigation canal at Dasheg kebele, Dolo Bay woreda

4.10.2 Reasons for pastoralist households not irrigating

Unlike agro-pastoralist households, pastoralist households depend only on livestock production and non-farm activities. The major reasons for pastoralist households not irrigating were lack of irrigable land near the rivers (85%), and lack of labor to involve in the irrigation activities (3%). Lack of land was the most important limiting factor of pastoralist households; however there was huge land which was not irrigating by agro-pastoralist households in the study area. Lack of awareness and extension services

development might be given additional consideration as a means of irrigation development low in the study area.

Figure 7:Soil fenced Irrigation canal while using plastic sheet at Fikow, Dolo Ado woreda

4.10.3 Years of experience on irrigation activities

According to table 9 below in the study area 78.8 percent of the agro-pastoralist participants stated that they have irrigation practice experience more than 7 years, however 21.2 % of agro-pastoralist participants experience irrigation practice from year 1-6. These show that the expansion of irrigation development in the study area is limited and there are numerous determinant factors for new entries as well as for the existing one also. Moreover, the existing agro-pastoralists already occupied water accessible land around the river in the study area. However, the study area still have potential for irrigation development if government and development partners construct better irrigation canal which access for more lands.

Table 9: Years of experience on small-scale irrigation activities by agro-pastoralists

Years	Obs.	Percent of agro-pastoralist Households responding
0-2 years	1	3
3-4 years	1	3
5-6 years	5	15.2
7 years and above	26	78.8
Total	33	100

Figure 8: Mango and Lemon farm left to right respectively at Genale-Dawa river basin and the picture shows more than 5 years trees.

4.10.4 Livestock income

The type of livelihood in the study area is agro-pastoralist and pastoralist system (i.e., integrated crop and livestock production). Livestock are the most important productive assets in the households in the study area especially for pastoralists because they depend only on this livelihood. Livestock are important source of power for ploughing, income, food and transportation. Livestock also consolidate the social organization as they serve in payment for blood compensation, slighting them during ceremony time and also gifts for relatives and neighbors. They play role in religious and cultural ceremonies and serve as source of prestige. It also considered as a saved asset used during periods of food shortage. The average livestock

holding for sample households was 8.59 TLU. Agro-pastoralist households possess a larger average number of livestock (9.06) than pastoralist households (8.23). There is a significant difference between agro-pastoralist and pastoralist households at the 1% significance level on average number of livestock, however, no significance difference on average annual income from livestock (Table 10).

Table 10:Average annual gross income and number of livestock(TLU)

Characteristics	Agro-pastoralist households (N=33)	Pastoralist households (N=33)	Total Household (N=66)	t-value for difference
Average annual income from livestock	57 672	43,130	50068	-.084
Average number of livestock (TLU)	9.06	8.23	8.59	.905**

**. Correlation is significant at the 0.01 level (2-tailed).

Livestock play a significant role as income sources in agro-pastoralist and pastoralist area of Ethiopia. Sale of live animals and their products are main livestock-related income sources in the study area. The livestock income category in the study area includes income from the sale of livestock only and it was not included by–products of livestock's. The values of sale of livestock were estimated based on the average annual prices.

Livestock farming system in the study areas is free grazing on communal grazing lands. There was high livestock income for both agro-pastoralist and pastoralist households due to the availability of communal grazing land and primary livelihood activities. However, agro-pastoralist households had better livestock income than pastoralist households due to agro-pastoralist households use by-products of crops and vegetables for their livestock consumption during severe drought time to maintain their body condition and protect from

death. From focus group discussions and key informant interviews stated that because the people have enough food from irrigated cropping, animals are not being sold to get food. Therefore, agro-pastoralist household has high livestock numbers and livestock income than pastoralist households.

As stated above the highest mean livestock income is reported in agro-pastoralist households. The average livestock income was ETB 57,672 with a minimum of 0 and a maximum of 599,992 ETB for agro-pastoralist. Whereas the mean income from livestock is reported from pastoralist households was ETB 43,130 with a minimum of 0 and a maximum of 278,000 ETB. Even if, the pastoralist households like agro-pastoralist households have communal grazing land there is poor livestock feeding sources during drought time and they did not practice alternative like cropping system to compensate the challenges they faced during severe drought. During drought period they sell their livestock frequently to purchase fodders and grain, as a result their livestock holdings and livestock income was low. Agro-pastoralist households had larger livestock income than pastoralist households, but statistically there is no significant difference. The overall mean income of livestock in all sample households is ETB 50,068 with a minimum of 0 and a maximum of 599,992 ETB. This indicates that livestock farming is main income source of the study area.

Moreover in the average livestock numbers in TLU for agro-pastoralists were 9.06 and for pastoralists were 8.23, which is significant difference at 1% level between the two.

Figure 9: Fodder production for livestock at Dolo woreda by Agro-pastoralists

4.10.5 Off-farm and other incomes

Like livestock and cropping income, off- farm incomes are important parts of total income in agro-pastoralist and pastoralist areas. Off-farming incomes increase the purchasing power of the sampled households in the study area.

Table 11: The mean off-farm income (petty trade , daily labour and others) by ETB

Characteristics	Agro-pastoralist households (N=33)	Pastoralist households (N=33)	Total Household (N=66)	t-value for difference
Off-farm incomes	10117.91	9680.82	9899.36	-.015

The average off-farm income for sample households was ETB 9899.36 (table 11). Agro-pastoralist households also get off-farm income from different sources (petty trade and donkey cart rent) .The difference in off-farm income between agro-pastoralist and pastoralist households are not statistically significant.

Figure 10: Local transport facility to cross or transport farm products on Genale or Dawa river

4.10.6 Summary of agro-pastoralist and pastoralist annual income sources at hhousehold level

The total annual household income in the study area was ETB 176,185.58 (Table 12), from the total annual income of a household, livestock contributes the highest income share (57.2%), cropping (31.5%) and off-farm (11.3%), respectively.

Agro-pastoralist households earn higher income from cropping than pastoralist households. However, there is no significant difference between agro-pastoralist and pastoralist households in their livestock and off-farm incomes. The total income significant difference arises from the cropping income difference, which indicate that irrigation practice increase agro-pastoralist household incomes.

Table 12: Summary of annual income sources

Characteristics	Agro-pastoralist households (N=33)	Pastoralist households(N=33)	Total households (N=66)	Percent	t-value for difference
Crop and vegetable income	55,584.85	0	55,584.85	31.5	.822**
Livestock income	57 672	43,130	50068	65.2	.052
Non-farm income	10,117.91	9680.82	9899.36	12.9	-0.063
Total income	123,374.76	52,810.82	176,185.58	100	-.318**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 11:Banana and maize product at Fikow and Dasheg left to right respectively by agro-pastoralists

4.11 Major challenges of the use of irrigation system among agro-pastoralists in the study area

Small-scale irrigation has immense potential to improve the incomes and livelihoods of poor agro-pastoral households in developing countries like Ethiopia, however, the contribution of irrigation on improving the livelihood of agro pastoralists are affected by a multiple factors. Some of the packages of successful irrigation systems include existence of effective water user associations, availability of agricultural inputs (quantity and quality), access to markets and dependable information, availability of socio-economic infrastructures, and access to complete extension services. However, the study area irrigation management and performance never free from challenges. A field survey with focus group discussion and key informant interviews indicates that small-scale irrigation's great contribution is accompanied with multiple determinant factors. The major challenges encountered in small-scale irrigation in the study area are problems related to fuel cost, institutional problems, the policy environment, design

issues, cultural factors and environmental problems. In this section major challenges that hinder irrigation development in the area were discussed.

4.11.1 Loss of water and easily damage of soil fenced canal

Loss of water and easily damage of soil fenced canal *is* the main problem in small-scale irrigation systems in the study area. The non-durability of the soil fenced structure of irrigation schemes and the sandy nature of the soil in the study area causes high water seepage from traditional river diversion canals. Outflow from irrigation canals is the main causes for water losses in and it consumes a lot of fuel cost for pumping water to irrigation areas. According to the FGD participants the soil fenced canal easily damage by water flow and it needs large labors to keep the water flow properly in the canal. In the study area the concrete canal irrigation not more than 1000 meters and which were constructed by Save the children International through USAID budget under Productive Safety Net Program two years ago. Most of the households were using soil fenced irrigation canal which consume large labor and motor pump fuel costs. Moreover, the canal is easy to expose water evaporation, water shortage and damage. The concrete canal covers only small distance and hence water would flow in traditional furrow until it reaches farmers‟ plots. In the meantime, considerable amount of water will be lost due to evaporation and infiltration. This decreases water efficiency and hence productivity of the land than otherwise.

Table 13:Type of irrigation canal in the study area

Type of Irrigation Canal	Number of respondents	Percent of agro-pastoralist household responding
Motor pump with soil fenced Irrigation canal(traditional irrigation canal)	29	87.9
Both concrete and soil fenced irrigation canal	4	12.1
Total	33	100

In the study area from the total agro-pastoralist only 12.1% of users using both concrete and soil fenced irrigation canal and the rest 87.9 % of agro-pastoralists were using Motor pump with soil fenced irrigation canal.

Figure 12:Traditional Irrigation canals at Fikow, Dolo Ado woreda

4.11.2 Lack of spare parts for water pumps and high cost of fuel

The lack of spare parts for motor pumps and high fuel costs are the main causes for reduced efficiency in small-scale irrigation in the study area. Since the availability of the rivers Dawa and Genale in the study area, motor pump irrigation is used by all agro-pastoralist households. The main problems in motor pump irrigation are the frequent damage of the pump, lack of awareness of how to operate, cost of fuel and the pump. The FGD discussion stated that they were bought on litter of diesel fuel (Benzele) by 33 ETB from local supplier. The FGD participants also stated that they were possess the motor pump from government support through credit. The government supplies the motor pump for a group of farm users. In the key informant interview and focus group discussion other main problems with motor pumps are lack of spare parts and non-functionality pumps due to long service. At present, most of these motor pumps are non-functional because of lack of spare parts and high price of fuel costs.

Figure 13: Broken motor pump at Dasheg kebele, Dolo Bay woreda

4.11.3 Lack of market and marketing facility

Market is considered one of the main problems in the study area. Cultivated vegetables using small-scale irrigations like onion, banana, papaya, tomato and the like are highly perishable and bulky crops, so an efficient marketing channel is necessary. In the study area households are traveling on average 36.09 km to get local market. The main market for Fikow kebele which is located at Dawa river basin is Mandera town, Kenya. However, this market situation is more uncertain because of Al Sheba movement around Ethio-Kenya border. When the security issue is unstable it is difficult for farmers to take their products to Mandera and as a result the farmers' product exposed for perishable and loss. The local market is far from this PA (Dolo Ado town) which is around 54 km far. Moreover, it is difficult to get transporter and storage system in the area as a result product quality deteriorates rapidly, which means that farmers must sell within a very short time, often at what they consider low prices.

Table 14:Setting selling price for agricultural production

Market decision makers	Number of respondents from the total interviewed agro-pastoralists	Percent of agro-pastoralist household responding
Your self	6	18.2
Market it self	17	51.5
Buyers	7	21.2
Negotiation	3	9.1
Total	33	100

In the study area 51.5% of the respondents from agro-pastoralists said that selling price is setting by market itself. Whereas the remaining 18.2%, 21.2% and 9.1% agro-pastoralist respondents said that selling price were set by farmer themselves, buyers and negotiation respectively.

Growers can produce large quantities of good-quality fruits and Vegetables, but, if they do not have a dependable, fast, and equitable means of getting such commodities to the consumer, losses will be extensive. This problem exists in many locations within developing countries. It is emphasized by lack of communication between producers and receivers, and lack of market information. Marketing cooperatives should be encouraged among producers of major commodities in important production areas. Such organizations are especially needed in developing countries because of the relatively small farm size. Advantages of marketing cooperatives include: providing central accumulation points for the harvested commodity, purchasing harvesting and packing supplies and materials in quantity, providing for proper preparation for market and storage when needed, facilitating transportation to the markets, and acting as a common selling unit for the members, coordinating the marketing program, and distributing profits equitable. However, all these issues were not applied in the study area.

4.11.4 Seasonality of River

There are rivers that have water for only some of the dry months. Their seasonality is unpredictable, varies depending on the climatic conditions each year in the highland parts of Ethiopia. This seasonality nature of rivers in the study area causes water shortage especially in the months of March and April. The Dawa river basin agro-pastoralists affected by this type of water shortage, the river diversion irrigation practiced on such river sometimes can easily dry up for two to three months. However, the Dawa river agro-pastoralists know the time of dry period of the river and they plant based on that assumption. From agro-pastoralist respondents 33.3 % of the respondents said that they are facing water shortage from 1-2 months. 9.1% of respondents said that they are facing water shortage for 3-4 months. However, the rest 57.6 % of the respondents said that they are not facing water shortage in the study area; most of these respondents are using Genale River, because Genale River has water throughout the year and its fluctuation not affect the farm activities of the study area.

Table 15:Number of month's water shortage faced by agro-pastoralists

Number of months water shortage faced by agro-pastoralists	Obs.	Percent of agro-pastoralist households responding
1-2 months	11	33.3
3-4 months	3	9.1
No faced water shortage	19	57.6
Total	33	100

Figure 14:Seasonality nature of Dawa river

4.11.5 Lack of credit source institution for farm activities

Unavailability of credit institution which provide loan for farm activity in the study area were indicted as constraint by key informants and FGD participants. The field survey also indicts that 30.3% and 24.2% of agro-pastoralists were received loan from friends/relatives and traders respectively. However, 45.5% of the agro-pastoralists said that they were not gets credit from any institutions. According to the study there were no Banks or Microfinance institutions which provide loan for farm activities in the study area.

Table 16:Credit source

Credit source for their farm	Number of agro-pastoralists responded	Percent of agro-pastoralists household responded
Friends/relatives	10	30.3%
Traders	8	24.2
Banks/micro finance	0	0
No credit source	15	45.5
Total	33	100

4.11.6 Inadequate Transportation Facilities

In most developing countries like Ethiopia, roads are not adequate for proper transport of irrigation products. In the study area agro-pastoralist and pastoralists are travelling 36.09 km to get local market and all round weather road. Moreover, transport vehicles are not easily accessible and the majority of producers has small holdings and cannot afford to own transport vehicles. In the study area 42.4 % of agro-pastoralists said that they were not gets transport facilities. However, the rest 57.6 % of the agro-pastoralists said that they have access for transportation for their products. Most of these are selling their products collectively, that why they can get vehicles.

Table 17:Transport accessability for irrigation products

Transport accessibility	Number of agro-pastoralists responded	Percent of agro-pastoralist households responding
Access to transport	19	57.6
Not access to transport	14	42.4
Total	33	100

Figure 15:local boat and banana product at farm gate

4.11.7 Inadequate farm inputs

Due to lack of farm inputs and other environmental constraints farmers in the study area focused on implementation of permanent and semi-permanent vegetable and fruit products like lemon, banana, mango and Papaya products. However, Onion and tomato products are repeatedly affected by pests they locally named"Adeye". This kind of pests affects the fruit and vegetable start drying from steam to leaf.

Imported inputs to control these problems, such as herbicides and pesticides, are costly for farmers to purchase and even not available in the local market. Therefore, diseases and pests can limit the economic benefits of small-scale irrigation activities in the study area. In the study area the price of imported inputs such as fertilizer and fuel has increased over time due to inaccessible because of limited supply by government. Moreover, limited knowledge and unavailability of proper varieties with respect to local climatic conditions, unavailability of improved seed and ploughing machines like tractor and hand tools also affect the irrigation products in the study area. According to the FGD participants stated that only one tractor available for Dolo Ado district and there was no tractor for Dolo Bay District.

Table 18: Types of input used by agro-pastoralists household

Input type	Number of agro-pastoralists responded	Percent of agro-pastoralist households responding
Chemical fertilizers	7	21.2
Improved seeds	11	33.3
Agricultural Chemicals	7	21.2

From the survey report only 21.2%, 33.3% and 21.2% agro-pastoralist used chemical fertilizers, improved seeds and Agricultural chemicals respectively in the year 2014. Moreover, 54.5% of agro-pastoralist said that they did not use farm inputs due to low accessibility in the area.

Figure 16:Un-functional farm input

4.11.8 Lack of proper post handling mechanism

Post-harvest losses vary greatly among commodities and production areas and seasons. In the United States, the losses of fresh fruits and vegetables are estimated to range from 2% to 23%, depending on the commodity, with an overall average of about 12% losses between production and consumption sites (Cappellini and Ceponis, 1984; Harvey, 1978.). Estimates of postharvest losses in developing countries vary greatly from 1 to 50% or even higher (National Academy of Sciences, 1978). Up to 30% of vegetable harvests in Ethiopia are reported to be lost due to poor post-harvest handling. Hence, of the vegetable production value chains should include productive diseases resistant varieties, agronomic practices, postharvest handling capacity for bulking, increased shelf life, new product development and delivery systems to markets (CSA 2008).similarly in the study area there is no proper post handling mechanism and farmers faced problem when their vegetable and fruits matured, especially due to the dry nature of the environment their products easily exposed for perishable and loss of their quality. Sometimes farmers were enforced to loss all their products on their farm before reaching to the market. Especially agro-pastoralists in the Dawa River sometimes face security problem on the side of Kenya and Somalia boarder to access market at the town of Mandera, Kenya. The main customers

of Fikow kebele irrigation products from cross boarder (Kenya). At the time farmers face market problem and their product easily perishable on the farm gate because of non-availability of cold storage facilities in the study area.

Figure 17:Poor post handling at Fikow kebele, Dolo Ado

4.11.9 Weak extension support service

Number of development agents assigned to work in each kebele not adequate in number to support farmer's right from land preparation up to post harvest handling and also they lack technical capability to support the farmers of their interest in the study area.

Moreover, Technical knowhow and experience with advanced fruit and vegetable cultivation is not yet adequately developed in the study area.

In the study area, different gaps are identified in relation to extension services and infrastructures. The Development agents in the study area were not available usually on the site and even the available one not focusing on the technical part rather they are focusing on political issues.

The major constraints and challenges reported by the farmers include improper crop rotation cycle; inappropriate cropping pattern and cropping intensity; poor soil fertility

management; crop-water requirement imbalance and inadequate crop pest management practices. This coupled with poor education background of farmers and absence of modern farming equipment's, the productivity of the plots is likely to be affected negatively.

Figure 18:Poor land utilization at Dolo Ado woreda

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The objective of this study was to provide empirical evidence on the comparison of irrigation based agro-pastoralist with pastoralist livelihood and identify major challenges of the use of irrigation systems in the study area. Although the agro-pastoralist and pastoralist households had the same demographic patterns, data for the study were collected from randomly selected agro-pastoralist and pastoralist households in the same area using semi-structured questionnaire in two weredas Dolo Ado and Dolo Bay (Genale-Dawa livelihood zone) taking two kebeles each namely Fikow and Dasheg.

Quantitative and qualitative data types related to impact indicators were collected from primary sources. Secondary sources also used to enrich data from primary sources. For this study two types of respondents; agro-pastoralist and pastoralists were considered for the survey.

The sample size was 66 (33 agro-pastoralists and 33 pastoralists). Statistical descriptive method employed to compare the irrigation based agro-pastoralist livelihood with pastoralists, the household income is one of the indicative for the comparison of the two livelihood and factors that affecting agro-pastoralist while intervene irrigation in the study area also the second focus area of this study.

This paper also examine factors influencing agro-pastoralists decision on whether or not to use irrigation in Genale-dawa river basin livelihood zone in somali regional state, Ethiopia. The descriptive statistic result showed that the major challenges encountered in using irrigation that respondents from agro-pastoralist households have stressed are loss of water and easily damage of soil fenced canal in the study area. According the survey 87.9% of agro-pastoralists were using motor pump with soil fenced irrigation canal. The second problem was lack of spare parts for motor pump and high cost of fuel. Since the availability of rivers Dawa and Genale in the study area motor pump irrigation is used by all agro-pastoralist households frequently damage of the pump, lack of maintenance, cost of fuel and pump were the main problem. The FGD participants stated that they were bought one litter of diesel fuel by 33 ETB from local market and this made

them to increase production cost from expected. Then lack of market and marketing facilitate seasonality of the river, lack of credit source institution, inadequate transportation facilities and inadequate farm inputs were the main problems faced by agro-pastoralists in the study area.

The statistical descriptive shows that irrigation accessibility affected by gender of the household head, accessibility to river and education level of the household head.

Male headed households are found to be more likely to engage in crop cultivation as compared to female headed households. Because the study shows most of the pastoralists are female headed households. This indicates that women have not benefited much from irrigation activities. To change this gender imbalance, programs that target both gender groups will be necessary to ensure equitable practice between male and female headed households on irrigation activities in agro-pastoralists and pastoralists.

Level of education also increases the participation on irrigation as compare to non-educated. This indicated the fact that irrigation technologies need special technical and managerial skills for their proper utilization. Hence, special training programs (on both operation and maintenance of the technologies) need to be instituted to manage irrigation technologies. Furthermore, availability of irrigation water is found to positively and significantly influence the use of irrigation activities. This implies that agro-pastoralists whose land is near a river have high opportunity to use irrigation than pastoralists whose land is locked far distance from the river or not having land.

On the comparison of the contribution of irrigation on household income, the total annual household income in the study area was ETB 176,185.58 (123,374.76 ETB for agro-pastoralist and 52,810.82 ETB for pastoralist household), from this total annual income of a household, livestock contributes the highest income share (57.2%), cropping (31.5%) and off-farm (11.3%), respectively.

Agro-pastoralist households earn higher income from cropping than pastoralist households. However, there is no significant difference between agro-pastoralist and pastoralist households in their livestock and off-farm incomes. The total income significant difference arises from the cropping income difference, which indicates that irrigation practice can increase household incomes. The annual income of a household from cropping income in

the sample livelihood zone was ETB 27,792.42. When the total annual cropping income of agro-pastoralist household was considerably significant however; the study shows that pastoralist households did not have any income from small scale irrigation activities because they not cultivating crop.

In general, there are important and significant differences between farm households who practice and did not practice irrigation. In terms of annual income 2013/14 harvest season, which showed from statistical descriptive result the average annual income of agro-pastoralist was significantly higher and has 70,563.94 ETB difference compared to the income of pastoralist household. This implies that the probability of being poor decreases if one has practicing irrigation, other factors being constant. This suggests that irrigation has significant contribution on improving the livelihood and annual income of agro-pastoralists when we compare with being pastoralists. Moreover, the study result shows that annual income of the agro-pastoralists was found to be better than that of pastoralists.

5.2 Recommendations

In the study area still there are many pastoralists and agro-pastoralists which are not participating in irrigation activities. This is because of lack of land which is access to irrigation, education, low access to market, lack of extension services, lack of appropriate irrigation canal, fear of fuel cost for motor pump, lack of credit source institution, seasonality of river, inadequate farm inputs, lack of post harvesting mechanism and other awareness enhancing systems. Based on the findings of this study the following general recommendations are given:

- Expanding the capacity of the agro-pastoralists and creating additional access through integrated water investment is important to increase agricultural income and hence leads to improve household's welfare.
- The policy implications of the above findings are that improved access to water for irrigation, educating and raising agro-pastoralists and pastoralists awareness through extension and provision of other complementary services would enhance the use of irrigation technologies. Particularly, affirmative action, in the form of targeted interventions, is needed to help female headed households

benefit from irrigation activities. Education is believed to have a positive impact on improving welfare and reducing poverty over time. Although education level of household heads was found to be positively correlated with participation decision into irrigation, in the study area 66.7 % of pastoralist households did not read and write (Illiterate) where as 81.8% of agro-pastoralist households are able to read and write. This low level of education would affect farmers to communicate with extension workers and to make sound economic decisions regarding crop production management, and cost benefit analysis. Therefore, the local education and agricultural offices should bridge this gap by introducing need based education and training programs for agro-pastoralists and pastoralists in the study area.

- Enhancing and improving the efficiency of the traditional irrigation systems such as: improving the durability of concrete and soil fenced irrigation canal, construct more river diversion canal, making simple, cheap and environmentally friendly irrigation technologies such as hand pumps and shallow tube wells, improving market access by building roads, price support and improving product quality and developing appropriate extension and credit services, and input supply system, prepare experience visit to model sites.
- The quality of water conveying canals has a great role in improving water efficiency in river diversion systems. Due to the cracks created in the concrete and soil fenced canals there is a substantial loss of water in the study area. Maintenance of the cracks and extending the main canal over wider distance can minimize seepage and improve transport efficiencies. The irrigated land coverage is also small compared with the potential of the area. The Bureau of Agriculture is responsible for irrigation development cooperated with governmental and non-governmental organizations.
- Land resource governance, including both land tenure institutions and access rights to natural resources, and also land use zoning, are an outstanding issue. In particular is the need to reconcile equitably the claims of both pastoralists and agro-pastoralists.
- A comprehensive irrigation development strategy should take into account the

technical requirements (e.g. equipment, spare parts, operation and maintenance), policy issues (e.g. incentives, pricing, cost recovery), and institutional issues (e.g. agro-pastoralist and pastoralist participation and organizations, extension and credit services, marketing, governance and management of water resource). Sectoral policies affecting water development should be harmonized. There is a need to determine the appropriate mix and role of government and non-government agencies, the private sector, communities and individuals in the effort to develop, control and manage water resources. Institutional mechanisms need to be put in place to minimize transaction costs and resolve conflicts.

- Addressing the infrastructure problem in the study area by upgrading the roads and through constructing bridges on Genale-dawa rivers and this would go a long way towards attracting a bigger market by making the agro-pastoralists and pastoralist more accessible.
- Access to irrigation has significant impact to promote total income and reduces the probability of households being poor. The major reasons for pastoralist households not practicing irrigation were lack of irrigable land near the rivers (85%), therefore, in addition to rivers the use of groundwater for small-scale irrigation is likely to be valuable for future irrigation development in the area.
- Returns to irrigation are affected by the marketing channel, in part because the main irrigated crops (onion and tomato) are harvested at similar times by agro-pastoralists and are perishable. An effective marketing system will facilitate irrigation adoption. Hence, the concerned bodies like governmental extension services, Agro-pastoralist cooperatives and non-governmental market organizations should support the further development of the efficient marketing systems in the study area. This may include provision of marketing facilities, information provision and monitoring of costs and returns in the supply chain.
- The important imported inputs are chemical fertilizers, herbicides and pesticides. In the study area, these inputs are used below the recommended level because of their high cost and shortage of supply. Access and proper utilization agricultural inputs are important for sustainable agricultural productivity and improvement. The

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

- The study was conducted at two kebeles as a result of budget constraint, hardship weather condition of the area and security problem. Hence, it becomes difficult to generalize about the impact of irrigation in the area by this study only. Therefore, a detail study that considers different agro ecological zones of the area and the actual impact of irrigation adoption on other indicators of household well-being should be undertaken.

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APPENDIX

A. Conversion factors

Table 19A: Conversion factor for Adult equivalent

Years of age	Men	Women
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
60 plus	0.84	0.74

Source: Getaneh Kebede (2011)

Table 20A2: Conversion factors for Tropical Livestock Unit(TLU)

Livestock Type	TLU
Ox	1.10
Cow	1.0
Heifer	0.50
Bull	0.6
Calves	0.20
Sheep	0.01
Goat	0.09
Donkey	0.5
Horse	0.80
Mule	0.7
Poultry	0.01

Source: Getaneh Kebede (2011)

B. Survey questionnaires

Module A: I. Sample Identification

101.Access to Irrigation	1 = Yes 2 = No					
102. Respondent Address/Name/Codes	Region	Zone	Woreda	Kebele	Sub kebele	Questionnaires I.D No.
103. Date of interview:				DD	MM	YY
105. Surveyors Conformation	Interviewer	Supervisor		Editor	Data Entry Clerk	
Name						
Signature						

II. Demographic characteristics of the Households

Details	Character	Results
202 Name of respondent(HH head)		
203. Age of Respondent		
204. Gender of respondent	1 = Male 2 = Female	
205. Marital Status of head of household	1 = Married 2 = Divorced 3 = Widowed 4 = Separated 5 = Single	

206. Education level of the household head	1.Illitrate 2. Read and write	
207. Total family members of the household? (please list them under below table)	_____	
Name	Age	Sex
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
208. What is the type of the household head house?	1. Grass roofed 2. Corrugated iron roofed house 3. Both	
209. What is your primary occupation?	1. Farmer 2.pure Pastoralist 3. Merchant 4. Fisher man	

	5. Other specify	

Module B: land size and utilization

300. Do you face labor shortage for your farm activities?

1. Yes
2. No
3 I haven't farm activity

301. If Question. #300 is the answer is yes, how do you solve the problem?

1. Hiring
2. Labor exchange
3. ***Debo***
4. Others specify_____

302. Total land own in hectors_____

303. Have you cultivated all your irrigable land last year?

1. Yes
2. No

304. If the answer for question # 303 is No, what is the total size of the land utilized for farm activities in hectors in last year_____?

305. If the answer for question # 303 is No, what are the reasons for not using all your land? (*Circle all appropriate*)

1. Shortage of family labor
2. Lack of seed
3. Lack of oxen
4. Lack of credit
5. Cost of fuel is high for motor pump
6. Other specify_____

306. Did you involve in land renting activities 2013/2014?

1. Yes
2. No

307. If your answer is yes for question# 306, in which activity are you involved?

1. Rented in
2. Rented out

308. If question # 306 is yes, how much is the cost of per hector for

1. Irrigable land_____
2. Non-irrigable land_____

309. What is the source of water for your irrigation?

1. River
2. Well
3. Spring
4. Pond
5. Others specify_____

Module C: sources of income of the Household

400. From where did you get income you used to cover all family expenditures? *(Please put in rank from given alternatives)*

1. Crop sells
2. Livestock sales
3. Remittance
4. Credit
5. Labor source
6. From aid assistance /PSNP and etc. /
7. Trade
8. Other specify _____

401. Are you agro-pastoralist?

1. Yes
2. No

402. If the answer for question # 401 is No, what is the reason not agro-pastoralist?

1. No farm land in surface water access
2. No awareness on it

3. No labor force to do

4. Due to fairing fuel cost for motor pump

5. Other specify_____

403. Which small-irrigation type you are using?

1. Traditional river diversion

2. Motor pump with concrete canal

3. Motor pump with soil fenced irrigation canal

4. Other specify_____

404. What is the distance between the sources of water to your irrigated land? _____

405. How long do you use irrigation farming?

1. 0-2 years

2.3-4 years

3. 5-6 years

4.7 year and above

5. I didn't use

406. Is the amount of water is enough to irrigate your land throughout the year?

1. Yes

2. No

407. If the answer for question 406 is No, for how long do you face the shortage?

1.1-2 months

2. 3-4 months

3. 5-6 months

4. More than 6 months

What mechanism do you suggest to solve the scarcity of water_____

408. Is there irrigation water use association around your area?

1. Yes

2. No

If the answer is yes, what are the benefit obtained from the association and your role?_____

409. Types of crops produced for last year (from February 2013 to January 2014)

Crop type	Size of land	Total production in kg	Consumed at home in kg	Quantity sold in kg	Price per quintal	Total value in birr
1.Maize						
2.Sorghum						
3.Lentil						
4.Beans						
5.Peas						
6.seasme						
7. Noug						
8.wheat						
9. others _____						

410. Vegetable and fruit production for last year (from February 2013 to January 2014)

Vegetable and fruit types	Size of land	Total production in kg	Consumed at home in kg	Quantity sold in kg	Price per quintal	Total value in birr
1. Tomato						
2.potato						
3.pepper						
4.onion						
5. Cabbage						
6. Kosta						
7. Others____						

_____						
Fruit						
1.Banana						
2.Papaya						
3.Lemon						
4.Mango						
5.Orange						
6.Others _____ ___						

411. Fodder production for last year (from February 2013 to January 2014)

Type of fodders	Size of land	Total production in kg	Consumed at home in kg	Quantity sold in kg	Price per quintal	Total value in birr
1. Sudan grass						
2.Maize						
3.Suspania						
4.						
5. Others_____						

412. From the above listed crops or vegetable which one is produced more in quantity for market in your area? *(Please put in rank)*

Crops *Vegetable and Fruit*

1st. _____ *1st*. _____

2nd._____ *2nd*._____

3rd._____ *3rd*._____

4th _____ *4th* . _____

5th._____ *5th*._____

413. Why do you select the above type of vegetable /crops for your irrigation farming?

1. Better price
2. Good production
3. High disease tolerance
4. Easiest to cultivate
5. Seed availability
6. Drought resistance
7. Other specify _____

414. from your Off-farm or non-farm activities on which one you are involved?

S.no.	Type of non-farm or off-farm activities	Annual income in birr
1	From petty trade /shop	
2	Mill	
3	Carts	
4	Remittance	
5	Aid Assistance	
6	Labor sale	
7	Firewood or charcoal sale	
8	Other specify	

415. Did you receive food aid PSNP or emergency from government or donor agencies in the year 2013/14?

1. Yes
2. No.

416. If the answer for question # 415 is yes, from which organization_____ and what quantity in quintal per year _____

Module D: Livestock production for last year (from February 2013 to January 2014)

500. Do you have livestock?

1. Yes

2. No

If yes please fill below table

S.no.	Type of livestock	Total number of livestock owned	Sold during the year		Bought during the year	
			Number	Value in birr	Number	Value in birr
1	Cow					
2	Bull					
3	Heifer					
4	Calf					
5	Ox					
6	Donkey					
7	Camel					
8	Shoats					
9	Poultry					
	Total					

Module E: Credit, market information and Extension Service

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

1. Yes
2. No

601. If yes, did you have access to credit for your farm activities?

1. Yes
2. No

602. If the answer for question # 601 is yes, What is the source of your credit?

1. Banks
2. Friends /relatives
3. Traders
4. Microfinance
5. from NGOs

6. Others specify_____

603. Do you receive any sort of extension services available in your locality?

1. Yes
2. No

If, no what is the reason_____

604. If the answer for question # 603 is yes, did you gain any knowledge from the extension agents that could help you to do things differently on the specific crops?

1. Yes
2. No

605. If the answer is No, for question 604, specify your reason_____

606. Is there any government or non-governmental organization working on irrigation development in your area?

1. Yes
2. No

607. If the answer for question # 606 is yes, can you mention these organizations with its contribution for the development of the irrigation activities?

Name of organization_____ and contributions

1._____
_____2.__
_____
_____3._____
_____
_____

608. Do you get market information about prices of agricultural inputs and outputs?

1. Yes
2. No

If yes please indicate the source of information _____

609. Who set your selling price?

1. Your self
2. Market it self

3. Buyers

4. Negations

5. Other specify_____

610. Do you use farm input in the year 2013/2014?

1. Yes

2. No

611. If question # 610 is yes, what kinds of input were used? *(Circle all appropriate)*

1. Chemical fertilizers

2. Improved seeds

3. Agricultural Chemicals

4. Other specify_____

From where did you buy these inputs?

_____

_____.

612. If the answer for question # 610 is No, what are the possible reasons for not using it?

(Circle all appropriate)

1. Unable to purchase

2. No credit facilities

3. Do not know its importance

4. Not available in the area

5. No production problem

6. Other specify _____

613. How far do you travel to get local market? _____km

614. Do you have transport access to the nearest market?

1. Yes

2. No

615. How far do you travel to get the service of all-weather roads? _____km

Module F. General Opinion

700. Please mention all determinant factors associated with irrigation development activities in your area? What action do you take to solve the problems?

701. Give your view as to what intervention must be made for better implementation of modern irrigation technology.

C. Key informant interview questionnaires

1. Respondent Address/Name/Codes	Region	Zone	Woreda	Kebele	Sub kebele
2. Date of interview:					
3. Name of Respondent					
4. Responsibility /title					
5. Sex	1. Male 2. Female				

6. What is the main livelihood of the community in your area?
7. Is there any responsible body for managing irrigation scheme in the community? How it is organized? What are the Criteria's to be member of the group?
8. What benefits do they get from water users association?
9. Is there any contribution from members of the association for the association? And for what purpose?
10. How do you sell irrigation products in general?
11. What are the major determinant factors for the irrigation users faced?
12. Do you get enough support from extension service? Or what services and assistance do the farmers get from your office?
13. What portion of land is utilized for farm activities currently in your district? Please Mention non-utilized also?
14. What are the major non-farm activities in your district?
15. Who are the primary buyers from farmers?
16. What efforts are done to encourage non-irrigation users to participate on irrigation?
17. What are the challenges and opportunities available for farmers?

118. Did you agree on the availability of income level difference between irrigation users and non-users?

D. FGD leading questionnaires

1. Please mention all determinant factors associated with irrigation development activities in your area? What action do you take to solve the problems?
2. Describe any socio- economic and environmental problems you have in the area?
3. Give your view as to what intervention must be made for better implementation of modern irrigation technology?
4. Give your idea with regards to any negative impacts and constraints of irrigation in your area?
5. What are the major problems in using motor pump for small-scale irrigation? What is your opinion about the solution?
6. What are the Major problem using soil fenced irrigation canals? What is opinion about the solution?
7. Is there any encouragement activities done by government or NGOs to participate on irrigation farm