

SMALL-SCALE IRRIGATION UTILIZATION BY FARMERS IN SOUTHERN ETHIOPIA



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SMALL-SCALE IRRIGATION UTILIZATION BY FARMERS IN SOUTHERN ETHIOPIA

Monograph

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The small-scale Irrigation Scheme is vital in assisting Ethiopia's sustainable agriculture development. Therefore, more small-scale irrigation schemes were developed in the country, including the Ella Small scale Irrigation Scheme, considering that irrigation is the apparent response to low agricultural productivity. This research aims to assess the current Irrigation scheme status of the farming households and investigate the factors affecting the farming households in utilizing the scheme. The selected sample size consists of both Irrigators and Non-irrigators farming households, including males and females. For the comparison, to identify the gender role and distribution of the resources equally at the Kebele level. The sample size was 100 household heads through a random sampling technique based on probability proportional to size. The researcher determined the sample size because of its representativeness at 10% of the total population. The data were both quantitative and qualitative. The quantitative data were collected by using a semi-structured interview schedule. In contrast, the qualitative data were collected using a checklist through Focus Group Discussion and Personal interviews with Key Informants. The PA was selected purposively by considering a small-scale irrigation scheme, relative accessibility, and a study area. The researcher knew well since it was one of the project areas for the researcher to work on. The secondary data was collected from different published and unpublished research works done by other researchers on similar or related topics and from stakeholders who directly or indirectly work on developing small-scale irrigation schemes and different records of the Government offices. Having collected data, it was analyzed in three statistical ways of data analysis; these were: Descriptive statistics such as mean, standard deviation, frequency and percentage. In addition, inferential statistics were employed to measure the degree of significant association of independent (explanatory) variables with the dependent variable. Finally, the econometric model employed was the Binary Logit model to examine the utilization of Small-scale Irrigation by farming households and factors that affect households not effectively utilizing the irrigation scheme under the study. The Binary Logit model results indicate the educational level of HHs, family size, landholding, livestock holding, frequency of extension contact, access to input supply, occupation of HHs and conflict over irrigation water utilization. Based on the above research findings that the following recommendations were suggested strengthening practical adult education, efficient utilization of labour of active family members, cultivation of high-value crops and vegetables that produces and harvests within a short duration, keeping their livestock from diseases and planting grasses for their forage along with the irrigated plot of the farm, frequent monitoring and evaluation of DAs at least twice a week, providing agricultural input at right cropping time, establishing agro-industries, strengthening Water Users Association and Conflict Resolution Committees.

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PREFACE

Introduction

Agriculture is the backbone of the Ethiopian economy, supporting the country's secondary and tertiary sectors' development. Moreover, agriculture is a primary sector that ensures self-reliance in national-level food availability. It also can enhance growth in the other sectors of the economy through increased commercialization and dynamic inter-sectoral linkage effects. The fast-growing population poses a problem to agriculture to increase the agricultural production and productivity per hectare of land. The low productivity of agriculture, coupled with other problems, has led to its poor performance of agriculture. Despite their noticeable achievements, efforts of Ethiopian farmers and development practitioners have failed to address the ground reality problems like irrigation water and different types of agricultural inputs requirements etc., to the village farmers. The watershed development and management concept is a top priority in irrigation water for farmers. The great expectation of the rural farmers is looking for a sufficient amount of irrigation water for agriculture that can be fulfilled by applying the Irrigation Scheme at the Kebele level, including institutional interventions.

Review of Pertinent Literature

Chapter two focused on the collection of different pertinent kinds of literature regarding this research title. First, the definitions and concepts related to Irrigation technology have been explained at the beginning of the chapter. Knowing the history and development of the Irrigation system and how far it was connected with empirical studies at the national level, including in Sub-Saharan Africa, is better. The volumes of literature were reviewed on socio-economic development and its impact on different factors, including many variables framed for the suitability of the research study. Those variables were incorporated into the conceptual framework of the study.

Methodology

The third chapter dealt with the study area and its geographical descriptions like land, rainfall, livestock and population data. The total geographical area is about to 86 646ha. 70% is Woyna Dega, 30% is Kolla, and 80% are engaged in agriculture. The Ella Small

Scale Irrigation Scheme has been chosen for this research. Ampho Koysha Kebele was selected purposively. The multi-stage sampling method was used to select the sampled respondents, $n = 100$, of which 24 households are Irrigators and 76 are Non-Irrigators. The primary quantitative data were collected with the help of an Interview Schedule from the farmer households. The qualitative data were collected using the Checklists from the Key Informants' Interviews and Focus Group Discussions with the Kebele Administrators, elders, and Development Agents. The Binary Logit Regression model was used to assess the irrigation utilization of the farmers' households in the Ampho Koysha Kebele. There are 16 Independent variables and two dependent variables

Data Analysis and Results

The collected data were analyzed, processed and interpreted in the tables. There are 16 Independent variables, of which 10 are Dummy variables and 6 are Continuous variables. The Contingency Coefficient for Dummy variables and the Variance Influence factor for Continuous variables were identified as the multi-collinearity problem. Seven independent variables are significant: Family households, Frequency of Extension contact, Access to Input supply, Occupation of Households, and Conflict over Irrigation Scheme utilization among farming households.

Out of the total 10 Dummy variables, seven variables were significant. The Occupation of household heads, access to input supply and access to market information were significant at less than a 5% probability level. Dependency ratio and irrigation Water Users Association membership were significant at less than a 1% probability level. The other four, i.e. dependency ratio of household heads, Education level of household heads, Access to market information of household heads and Conflict over irrigation water, were significant at less than a 10% probability level. The rest of the discrete variables were insignificant, such as the Sex of household heads, Access to credit, and the Farmers' Perception of the Irrigation Scheme utilization. The results of the logistic regression discuss the results of the significant variables determining the decision of households whether or not they utilized the Irrigation Scheme. All the variables discussed in the previous sections were considered for the model and tested for their significance. The binary logistic results are presented in Table 26 shows the estimated coefficient (β values), standard error, significance values and odd ratio of the independent variables in the model.

Conclusion

The study was conducted in one Kebele where the Irrigation scheme, situated in the Humbo District, falls under the Wolaita Zone. The random sampling procedure was used to select the 100 respondents in the Kebele Ampho Koysha. The Interview Schedule is used for quantitative data collection, and the Checklist is used for Focus Group Discussion. The primary tools completed the Key Informants Interview for qualitative data collection, and the process of collecting data was based on face-to-face interviews. There were 16 different independent variables selected to conduct the study. After, their co-linearity was tested by using both contingency coefficients for the dummy and variance inflation factors for continuous variables, respectively. One variable was not correlated with the remaining independent variables; the researcher rejected it before entering variables into binary logistic regression for analysis. The independent variables were selected under four factors, namely: Socio-demographic, Institutional, and Psychological, Economic factors, by referring to secondary sources. The data gathered from the sample units were analyzed using descriptive and inferential statistics.

Recommendations

The Government and Bureau of Agriculture and Rural Development Office have to mandate to development of smallholder farmers, as stakeholders have to facilitate and involve productive-oriented jobs such as agro-based industries to create a farm market produces and prevent low prices due to excess production. In addition, employment and new business opportunities could benefit landless and/or low-income households. They depend on irrigation farming as their primary occupation and a sector that generates many incomes and sustainable livelihood strategies.

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FOREWORD



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Impact of the Digital Technology

Recent technological developments such as explosive growth of the Internet and www sophisticated search engines, fast processing power and reduced cost of computers, high bandwidth networks and an increasing number of electronic publications assist the libraries in providing extensive access to a variety of information sources and provide a way to enrich the teaching and learning environment. As a result, worldwide libraries face changes in the concept, organization, functioning and management of library and information systems worldwide. Modern Digital libraries incorporate new technologies, upgrading information resources to add value to web services and ultimately satisfying the increasing information needs of modern digital users.

One of our academic staff Dr.M.Senapathy from the Department of Rural Development and Agricultural Extension, College of Agriculture, Wolaita Sodo University, has taken scientific steps to publish E-book. It was designed for Graduate students and research scholars abroad who are pursuing research on Rural Development background, Sociology, social work disciplines, etc. Its main aim is to help research scholars who are looking for African countries' studies. Those who have chosen research on Rural Development mainly focus on methodological frameworks in their diverse and pluralistic nature and demonstrate their purpose, relevance, and effectiveness.

Distinct Advantages of E-Books

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First and foremost, the Rural Development research titles have been compiled and contributed to world readers and users in general. This E-Book has five chapters: Introduction, Literature Review, Methodology, Results and Discussion and Summary, Conclusion and Recommendations, including Appendices. In this sense, the E-Book is concise and comprehensive and offers a complete research analysis of the particular research title of information in a relatively small space.

The E-book enlightens the knowledge of budding research scholars/Graduate students at the M.Sc. and PhD levels. It also covers many pertinent literature reviews, detailed information about the study area and methodology, and statistical tools applied with recommendations. Finally, the E-Book presents social research as a dynamic process leading from beginning to end and showing clearly how researchers progress from one stage to the next, how decisions are made, how sampling methods are selected, and how conclusions and recommendations are drawn.

The E-Book offers Graduate students the need to know about social research: what it is, what it does, how it is used when it is used and for what purpose, what methods it employs, and a critical understanding of rural locality-based research. Such an intensive analysis may be accomplished through further reading to update the modern trends in research. As a result, Social work, Psychology Anthropology and other social sciences are in general.

Ideally, this E-book was prepared for beginners who wish to understand the meaning of the research and intend to conduct an elementary investigation. Nevertheless, an intelligent scholar may find the E-Book a good model for ordering, categorizing and integrating the embodiment of complete research knowledge in the social sciences.

At the outset, I appreciate our staff Dr.M.Senapathy who has made extraordinary efforts to prepare this E-Book on chapter-wise with a precise sequence. Hope this E-Books publication output will impart a new E-learning opportunity to our students in Ethiopia, particularly the world users.

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LIST OF ABBREVIATIONS

ADLI	: Agriculture Development Led Industrialization
BLR	: Binary Logistic Regression
BoFED	: Bureau of Finance and Economic Development
CD	: Canal Diversion
CRS	: Catholic Relief Service
CSA	: Central Statistical Agency
DA	: Development Agent
ETB	: Ethiopia Birr
FAO	: Food and Agricultural Organization
GD	: Focus Group Discussion
GDP	: Growth Domestic Product
GoE	: Government of Ethiopia
GTP	: Growth and Development Plan
HHs	: Households Head
IDD	: Irrigation Development Department
IFAD	: International Fund for Agricultural Development
KM	: Kilo Meter
MoA	: Ministry of Agriculture
MoFED	: Ministry of Finance and Economic Development
MoWR	: Ministry of Water Resource
NGOs	: Non-Governmental Organizations
OLS	: Ordinary Least Square
PAs	: Peasant Associations
PASDEP	: Plan for Accelerated and Sustained Development to End Poverty
PPS	: Population Proportionate Sampling
PSNP	: Productive Safety Net Program
SIDA	: South Irrigation Development Authority
SNNPR	: Southern Nation Nationalities and People Region
SSI	: Small Scale Irrigation

LIST OF ABBREVIATIONS (CONTINUED)

SPSS	: Statistical Package for Social Science
TLU	: Tropical Livestock Unit
VIF	: Variance Inflation Factor
WB	: World Bank
WUA	: Water Users Association
WUC	: Water Users Committee

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SMALL-SCALE IRRIGATION UTILIZATION BY FARMERS IN SOUTHERN ETHIOPIA

ABSTRACT

The small-scale Irrigation Scheme is vital in assisting Ethiopia's sustainable agriculture development. Therefore, more small-scale irrigation schemes were developed in the country, including the Ella Small scale Irrigation Scheme, considering that irrigation is the apparent response to low agricultural productivity. This research aims to assess the current Irrigation scheme status of the farming households and investigate the factors affecting the farming households in utilizing the scheme. The selected sample size consists of both Irrigators and Non-irrigators farming households, including males and females. For the comparison, to identify the gender role and distribution of the resources equally at the Kebele level. The sample size was 100 household heads through a random sampling technique based on probability proportional to size. The researcher determined the sample size because of its representativeness at 10% of the total population. The data were both quantitative and qualitative. The quantitative data were collected by using a semi-structured interview schedule. In contrast, the qualitative data were collected using a checklist through Focus Group Discussion and Personal interviews with Key Informants. The PA was selected purposively by considering a small-scale irrigation scheme, relative accessibility, and a study area. The researcher knew well since it was one of the project areas for the researcher to work on. The secondary data was collected from different published and unpublished research works done by other researchers on similar or related topics and from stakeholders who directly or indirectly work on developing small-scale irrigation schemes and different records of the Government offices. Having collected data, it was analyzed in three statistical ways of data analysis; these were: Descriptive statistics such as mean, standard deviation, frequency and percentage. In addition, inferential statistics were employed to measure the degree of significant association of independent (explanatory) variables with the dependent variable. Finally, the econometric model employed was the Binary Logit model to examine the utilization of Small-scale Irrigation by farming households and factors that affect households not effectively utilising the irrigation scheme under the study. The Binary Logit model results indicate the educational level of HHs, family size, landholding, livestock holding, frequency of extension contact, access to input supply, occupation of HHs and conflict over irrigation water utilization. Based on the above research findings that the following recommendations were suggested strengthening practical adult education, efficient utilization of labour of active family members, cultivation of high-value crops and vegetables that produces and harvests within a short duration, keeping their livestock from diseases and planting grasses for their forage along with the irrigated plot of the farm, frequent monitoring and evaluation of DAs at least twice a week, providing agricultural input at right cropping time, establishing agro-industries, strengthening Water Users Association and Conflict Resolution Committees.

Keywords: Small-scale Irrigation Scheme, Focus Group Discussion, Water Utilization.

CHAPTER I

1. INTRODUCTION

1. INTRODUCTION

1.1. Background of the study

Agriculture is the mainstay of the Ethiopian economy as it accounts for about 46% of the GDP, 85% of the export and 80% of the employment opportunities (Makombe *et al.*, 2007). Both industry and services depend strongly on the performance of agriculture, which provides raw materials, and generates foreign currency to import essential inputs and food for the fast-growing population. Despite its importance for the national economy, agriculture is primarily based on subsistence farming. The productivity of the agricultural sector is very low and lags behind the population growth rate resulting in food insecurity. The Ethiopian Government designed an Agricultural Development Led Industrialization (ADLI) strategy to address this problem, which aims to use agriculture as the base for the country's overall development (MoWR, 2001). This Strategy aims to enhance small-scale farmers' productivity and improve food security in rural and urban areas. One of the policies within this strategy is to stimulate and/or support small-scale irrigation development. The majority of the agricultural sector depends on rainfall. Irrigation and improved agricultural water management provide opportunities to cope with climatic variability, enhance productivity per unit of land, and increase production volume.

The irrigated area increased rapidly; in 1995, it was 75,000 ha. In 2003 it had increased to 200,000 ha. additional 274,612ha. under irrigation, until 2016 (Diao and Nin Pratt 2007). According to (Demese *et al.*, 2009), the current yield levels by rural smallholders are not able to produce to fulfil their minimum food requirements since one-third of the rural household owns less than 0.5 ha of farming land that is dependent on rain-fed agriculture system. Similarly, (Seleshi *et al.*, 2005) confirmed that the food production status of the country has to be doubled by 2025 compared with the current production level to meet the food demands of the growing population of Ethiopia concurrently. Otherwise, continuing the production drive and supplying the required food for the population will be challenging. Hence, the permanent resolution of the country's short and long-term food shortage situation brings modern agricultural mechanisms to enhance production and improve the country's overall economic, social and institutional contexts (Mekuria, 2003). To this end, the large food deficit situation of the country, both at the National and

Household level, cannot be resolved through rain-fed agriculture alone (Desta, 2004). Due to this fact, the Ethiopian government has been involved in Irrigation Development works to improve agricultural production, mainly focusing on drought-prone affected areas of the country since the mid of 1980s (Woleddeab, 2003).

A priority is given to irrigation by the current government to promote multiple cropping of food and cash farming systems to cope with climate inconsistency and ensure food security at the household and national levels (MoFED, 2010). As stated in the Growth and Transformation Plan (GTP) document, the lessons learnt from the past two ten years of national development programs have given a direction to be considered in areas mainly encountered with delaying in entrance of rainy seasons, early withdrawal and mal-distribution problems. The principles and strategies declared in this document are an extension of MoWRD (2002), which is planned to utilize the available water resources to expand small, medium and large-scale irrigation schemes focusing on promoting a market-oriented farming system by smallholders. Click here (<https://www.youtube.com/watch?v=InTaMImxoqQ>)

Some scholars have argued that Ethiopia has to learn the farming experiences of Ghana and other Asia countries on the utilization of irrigated lands in the production of the consumable package of food crops rather than encouraging them to cultivate vegetable and/or industrial crops, which have an indirect and limited effect on household food security situation (Tsegaye and Tamene, 2005).

So far, in Ethiopia, studies on analyzing the contribution of irrigation to food security improvement have been focused on large-scale irrigation schemes, which were established and managed by the state (Seleshi *et al.*, 2005). Government policies relevant to small-scale irrigation include the Water Resources Management Policy, the Water Sector Strategy, the Water Sector Development Programme, the Food Security Strategy, and the PRSP. The thrust of these publications is to emphasize the GoE's commitment to (a) small-scale irrigation, (b) enhanced food security for the majority rural population (84%), (c) environmental rehabilitation, and (d) gender mainstreaming. The GoE plans to increase the estimated existing 98,625 hectares of modern SSI to about 180,000 hectares by 2016, although the realization of this ambitious target will depend strongly on external

funding. While the stated support for SSI is encouraging, there is a concern that the GoE and others may think of SSI as a final solution to tap agricultural production.

The country's irrigation potential is estimated to be about 3.7 million hectares. Of the total potential, until now, only about 20 to 23% of this potential is put under irrigated agriculture (both traditional and modern irrigation systems). Recent estimates indicate that the total irrigated area under small-scale irrigation in Ethiopia has reached 853,000 ha during the last implementation period of PASDEP – 2009/10, and the plan set for the development of small-scale irrigation is 1850,000 ha, which is planned to be achieved by the end of the five years GTP of 2015. Click here (<https://www.youtube.com/watch?v=NirEpFYN2dM>)

1.2. Statement of the Problem

Humbo Woreda has been declared one of the insecure food Woreda is between Wolaita Zone Woreda and the nation, mainly attributed to erratic rainfall occurrences. The study area, Ampho Koisha Kebele, is known for its food insecurity situation due to the erratic rainfall, small landholding, and less productivity of farmlands problem for the past decades. The study Woreda, Humbo notably shares the food deficit situation due to the erratic, unpredictable, and low rainfall situation. To this end, as the PSNP implementation plan describes, 51,775 people (37% of the Woreda population) were targeted to supply 3261.825 food transfers from 2010-2014. In effect, the erratic rainfall coupled with the existing small land holding will be an illusion for ensuring food security (Hussian and Bhattarai, 2003).

Hence, the government, development partners and communities have made many technical efforts to improve the food security situation of smallholders by creating access to irrigated agriculture. The perennial Hamasa River, found in the eastern part of Humbo District, was targeted to serve one accessible Kebele, named Ampho Koisha, in the Woliata Zone of SNNPR in 1985. Likewise, a preliminary assessment made by District Agriculture Office in 2012 observed that the irrigation water utilization status had not shown any progress, which has a tremendous effect on agricultural production and the food security situation of the area. Since irrigation is one of the intervention strategies to maximize productivity and ensure the food security condition of the smallholder farmers in

the study area, the status of utilization of the scheme by the farming households was not currently better. The Government expected to intensively utilize irrigation water to ensure their food security status and become more productive of high-value crops that earn a high income and are produced in a short cropping season without looking at rainfall. However, when the researcher tried to look at the impressive objective designed by the government, the utilization condition of the scheme was not observed in line with the stated objective. As a result of different affecting factors, some of the irrigating households could not fulfil the food consumption expenditure of their households. Finally, they faced a food shortage problem during the dry cropping season and looked for food assistance, primarily when they were recruited as Safety Net beneficiaries.

Due to this fact, it is a fundamental issue to assess the extent of irrigation utilization status by using Ella Small-scale Irrigation to ensure the productivity of high-yield crops and challenges faced by the community in utilizing the constructed scheme at the grass-root level. This could contribute to improvements in their performance. There is a need to understand better the factors affecting the smallholder irrigation scheme utilization in the Wolaita Zone, particularly in the Humbo District.

This research study tries to fill the gap in the developmental activities that the Ella Small scale Irrigation Scheme contributes for multiple cropping without the need for rainfall by households in the study area. It paves the way for other researchers to conduct further research on related topics or their performance and contribution to the households' food security. The result will be a ready reference tool for the policymakers and development planners of the study district and country.

1.3. Objectives of the study

1.3.1. General objective

The study's general objective is to analyze the farming households' small-scale irrigation scheme utilization status and the responsible factors that affect the utilization of the existing scheme understudy in Humbo District, Wolaita Zone.

1.3.2. Specific objectives

The Specific objectives of the study were:

1. to assess the current irrigation scheme utilization status of the farming households and
2. to investigate the factors that significantly affect farming households in the utilization of irrigation schemes.

1.4. Research Questions

The specific questions are as follows:

1. What is the current status of the irrigation scheme in the study area?
2. What are the significant factors that are affecting farming households in the utilization of irrigation schemes?

1.5. Scope and limitation of the study

This study merely analyzed small-scale irrigation scheme utilization status by the farming households in Humbo District, Wolaita Zone.

The study focuses on assessing the current irrigation utilization status of the Ella small-scale irrigation scheme by farming households and investigating the factors that significantly affect farming households utilising the irrigation scheme. The research study was confined to one small-scale irrigation scheme. Hence, the results and finding on the problem and improved situation are the reflections of the study area, which may be difficult to replicate in other areas of the zone and region. Due to budget and time constraints, the study only uses current socio-demographic, economic, Institutional and psychological factors information rather than time-series data.

1.6. Significance of the study

Information is on the Analysis of Small Scale irrigation utilization status on the individual farming household regarding productivity in on-farm activities such as rain-fed, irrigation, rain-fed irrigation, livestock, and other total incomes like non-farm and off-farm activities.

Institutional-related issues like access to credit, market information, input supply, frequency of extension contact and membership in the water users association. In terms of general socio-demographic information of households like age, sex, educational level, occupations and dependency ratio of the households and related psychological factors like farmers' perception towards the utilization of irrigation scheme and its significant factors that are affecting the utilization of small-scale irrigation scheme need to be well documented for planning purposes. Information collected during the data was collected, and findings obtained from the study will help government policymakers, district agriculture office experts', development agents working in the study area, and NGOs formulate appropriate policies and design practical evaluation and development programs. The result can also be used as input for researchers involved in a similar thematic area to further knowledge generation in concepts related to irrigation development and its determinants in erratic rainfall areas of the Region. Click here (<https://www.youtube.com/watch?v=NirEpFYN2dM>)

1.7. Organization of the thesis

Chapter one thesis was structured as follows: background of the study, statement of the problem, research objectives, research questions, scope and limitations of the study, significance of the study and organization of the thesis. Chapter two reviews theoretical and empirical literature related to irrigation schemes and agriculture. Chapter three deals with the research methodologies and description of the study area, respectively. Chapter four provides research results and discussions about analysing the Ella irrigation scheme's small-scale irrigation utilization status. Finally, chapter five summarizes the study's main findings and draws conclusions and recommendations.

CHAPTER II

2. REVIEW OF PERTINENT LITERATURE

2. REVIEW OF PERTINENT LITERATURE

In this chapter, theoretical and empirical literature were reviewed and presented accordingly, and the conceptual framework was figured as follows.

2.1. Definition and Concept Related to Irrigation Technology

2.1.1. Definition of Irrigation

Irrigation is the artificial application of water to the soil for crop production. Irrigation water is supplied to supplement the water available from rainfall and contribute to soil moisture from groundwater (Michael, 1997). Irrigation is a scientifically supported artificial mechanism for taking water to fertile land and using it (Teju, 2000).

Again, FAO (1997) defines irrigation modernization as a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation systems combined with institutional reforms, intending to improve resource utilization (labour, water, economic, environmental) and water delivery service to farmers (FAO, 1997 in FAO, 2003:5). From the above discussion, one can understand that an irrigation facility is a physical structure that brings social and environmental component together for bringing sustainable development.

2.1.2. Small-Scale Irrigation System

Irrigation systems can be classified according to size, source of water, management style, degree of water control, source of innovation and type of technology. In terms of management, governmental managed, the farm managed and jointly managed irrigation schemes in Ethiopia (Yusuf and Tena, 2007). Similarly, Angelle (2007) puts traditional irrigation schemes, modern small-scale irrigation schemes, modern private irrigation and public irrigation depending on the size and type of technology, type of management, degree of water control, and size of the land (Angela, 2007:28-29).

Small-scale irrigation may be defined as irrigation, usually on small plots. Private farmers have the primary controlling interests and use a technology level to operate and maintain themselves effectively. An important objective in promoting small-scale irrigation has been

to increase farmers' involvement in the design, implementation, operation, and maintenance of irrigation systems. Indeed, small-scale schemes are defined as schemes that are controlled and managed by the users themselves. Click here (https://www.youtube.com/watch?v=t626_nkM8ho)

2.2. History of Irrigation Development

Over 5000 years ago, runoff irrigation was practised in Java, Palestine. At the same time, so-called hydraulic societies developed in large river valleys, such as the Yangtse in China, Indus in India, the Euphrates in Iraq and Nile in Egypt. Laws and by-laws regulated the distribution of irrigation water, which dominated farmers' and citizens' life cycles. For example, some 1500 years ago, the Marib dam in Yemen raised the water level of a non-perennial river to divert floods for irrigation purposes (FAO, 1997/98/99:1).

According to Andarge (2009), irrigation in Ethiopia probably predates Sematic-speaking immigrants from Yemen and possibly agriculturalists from Sudan. Both groups may have introduced seed/plough cultivation and irrigation to Northern Ethiopia in the later Axum Empire between 1000 B.C. In the 15th and 16th centuries, the Portuguese missionaries Alvarez and Almeida reported irrigation in various localities in the northern highlands and among the Afars in the lower Awash Valley (Andarge, 2009:13).

From the above, one can understand that irrigation is an age-old art, perhaps as old as civilization. Nevertheless, the increasing need for crop production due to the growing population in the world necessitates a rapid expansion of irrigated agriculture worldwide, mainly small-scale irrigation.

2.3. Irrigation Development in Ethiopia

Since the earliest times, Ethiopian farmers have practised agriculture using technology to sustain the food supplies of the low population. To date, agriculture forms the basis of the Ethiopian economy, contributing up to 50% of the GDP, 90% of total export earnings and providing a livelihood for 85% of the population. However, though agriculture is the primary economic sector, its production is mainly subsistent and predominantly rain-fed, and as a result, it has suffered from recurrent drought and unreliable rainfall.

Traditional irrigation is ancient in Ethiopia. The traditional small-scale schemes are, in general, simple river diversions. The diversion structures are rudimentary and subject to frequent damage by floods. Modern irrigation was started in the 1960s by private investors in the awash middle valley, where large quantities of sugar cane, fruit and cotton were produced. With the 1975 rural land proclamation, the large irrigated farms were placed under the responsibility of the Ministry of State Farms. Almost all small-scale irrigation schemes built after 1975 were organized into producers' cooperatives (FAO, 1995).

For much of the lifetime of the Derg, very little attention was paid to small-scale and traditional irrigation schemes constructed and managed by peasant farmers. Instead, with the nationalization of industrial and agricultural enterprises, the government emphasised promoting high-technology water development schemes managed by state-controlled agro-industrial and agricultural enterprises. Only in the second half of the 1980s, because of the devastating famine of 1984/85, the Dreg began to show interest in small-scale water management schemes.

The establishment of the Irrigation Development Department (IDD) within MoA at the end of 1984, a body entrusted with developing small-scale irrigation projects for the benefit of peasant farmers, signalled a new approach to water development by the military government. However, progress was slow. From the mid-1980s to 1991, IDD constructed some 35 small schemes, of which nearly one-third were formerly traditional schemes used by peasants (Dessalegn, 1999). There are various estimates by different organizations concerning the country's irrigation potential. FAO (1994) estimated it at about 1.8 million hectares, while IFAD 1985 estimates 2.8 million hectares. According to the MOA report of 1993, the total coverage of irrigation in the country was only 168,000 hectares, less than 6% of the country's average estimated potential of 2.7 million hectares (as cited in Fuad 2001).

Moreover, Dessalegn (1999) that, in Ethiopia, irrigation covers less than two per cent of the cropped land and the fact that if all the irrigated land is utilized to produce food crops, the contribution of irrigation to the production of food cannot exceed two per cent has also been indicated. This shows that regarding the country's endowment with potentially huge irrigable land, irrigation has made little contribution toward agricultural development and national food self-sufficiency in Ethiopia. Click here (<https://www.youtube.com/watch?v=HJvRmxexT6w>)

In most of Ethiopia, production from rain-fed agriculture is highly fluctuating, corresponding to the amount and distribution of rainfall. Because of little rainfall or uneven distribution pattern, crop failure is undoubtedly to come. For example, Webb and Von Vraun (1994) estimated that a 10% decline in rainfall below the long-term national average would result in a fall in all cereal yields by an average of 4.2%. Such a failure in agricultural production has caused great distress and famine for three or four decades.

Irrigation Agriculture is the priority of the Ethiopian government's agriculture transformation and food security strategy. Increased availability of irrigation and less dependency on rain-fed Agriculture is taken to increase food production and self-sufficiency of the country's rapidly increasing population. In addition, in line with the development policy, regional states and NGOs promote irrigation development to increase and stabilize food production. (Awulachew *et.al.*, (2005).

2.4. Irrigation Development in SNNPR

Uneven distribution of rainfall in the country in general and in the South region, in particular, makes irrigation the best way to enhance food production. The development of small-scale irrigation schemes is the best alternative as they require minimum investment & their gestation period is comparatively low. The southern region has been implementing such schemes as part of the country. Despite remarkable achievements, some implemented schemes have failed, and some are performing below their capacity. A case study was conducted in 26 existing Small scale Irrigation works (about 1/3rd of the total schemes) in the South Region attempt was made to understand the causes of the significant problems that are related to the design consideration of the different components of the structure and identify the gap in knowledge between the current design practices and performance of the Irrigation structures. The pre and post-construction institutional aspects, planning, social, economic, operation & utilization aspects are also given due attention. It has been identified that some of the physically observed problems of the existing irrigation structures such as canal siltation (50%), sedimentation of the headwork (42%), the problem of seepage through the foundation (4%), main canal seepage (33%), scouring of the downstream bank (8%), drying of rivers (12%), damage on the impervious and flexible apron (19%), change of river course (12%), damage of under

sluices (27%) and damage on CD works (4%). Likewise, some of the planning, institutional and operation problems are lack of adequate community participation, water right conflict among up streamers and down streamers (12%), market outlet problems (8%) and proper handing over the problem (31%), lack of proper training and the like. During the study, 18 % of the irrigation schemes of the region were not operational because of those mentioned above and related reasons.

In SNNPR, individual farmers and private and public commercial entities develop irrigation. NGOs and SIDA, beneficiary communities for irrigation development, are selected by SIDA. Some NGOs have identified the prevalence of drought and food insecurity, high population pressure, water resource potential, land suitability, equity in resource distribution among various Zones or Woredas, interests of the communities to practice irrigation and willingness to contribute to the project. In the SNNPR region, the small-scale irrigation schemes are 49; by these schemes, over 6,509 ha and 23 349 people benefit from it, and the region has the potential to 2 542.

2.5. Current status of Small-Scale Irrigation Systems

Irrigation in Ethiopia has been classified into three classes. They are small, medium and large-scale irrigation schemes. Small Scale supplies a total command area of under 200 ha instead of medium and large scale, 200-3000, and above 3000 ha respectively (MWR, 2001b).

The present most frequently cited estimate of small-scale irrigation estimated area is about 65,000 has (MWR, 1998; MOA, 1993 as cited in CRS, 1999)). These figures are in sharp contrast to the widely cited overall potential for irrigation throughout the country, including small, medium and large-scale irrigation.

The present levels of the total area estimated to be under SSI are less than one per cent of the total area currently being farmed. A similar analysis could be carried out based on population and small-scale irrigation users. Small-scale irrigation systems vary based on the water source and distribution technology. These systems are diversion, spate, spring and storage systems and are defined as follows by (CRS 1999):

- River diversion systems are off-take systems and are the most common form of irrigation system in Ethiopia. Diversion systems utilize natural river flow; however, river

flow regulation via a permanent structure in the riverbed is also expected to increase the off-take. Diversion systems abstract water over a sustained period and can deliver regular irrigation throughout the cropping regime. A key characteristic of diversion systems is the adequacy of water supply during the dry seasons and the ability to irrigate a dry-season crop and provide supplemental irrigation during the rainy seasons.

- Spate systems use the occasional flood flows of streams and operate during part of the year, and there are two types of spate systems. The first, a run-off system, diverts flood flows in high land areas. The second, most common on foothill sites in arid and semi-arid areas, divert flood flows originating in highland areas. However, spate systems have proven challenging to rehabilitate due to designing weirs to divert flows that change over a short period and resist structural damage from flood flows.
- Spring systems use small spring flows. Water is often shared with household and livestock users, stored overnight in small reservoirs, and emptied daily.
- Storage systems are earthen dams that store water for an extended period behind dams. In Ethiopia, the recent introduction of storage systems poses technical and production challenges. It is essential to consider the catchment flow and amount of sediment in designing storage systems. Cropping must be planned according to the amount of water stored and available for irrigation. Typically, the irrigable area is much more prominent during the rainy season than during the dry season.
- Lift systems extract water from rivers, irrigation canals, reservoirs and wells. As a result, lift systems have lower development costs. Manual or motorized pumps are used.

2.6. Related Empirical Studies on Irrigation

Smallholder farmers' issue of irrigated agricultural practice is one of the development topics in developing countries. This is due to its contribution to increasing agricultural yields, food production, income, and food security. Thus, in line with this study, some related empirical studies on irrigation are discussed below.

The study was designed to assess the economic linkages of smallholders' irrigation development and issues of community management in the East showa administrative Zone of Oromia Regional State; Lemma *et al.* (2004) concluded that community irrigation practices that integrate food crop, cash crop and livestock production could help to tackle the existing chronic food security problem and can become sources of employment and income generation for the local people.

Wagnew (2004) conducted a case study using a formal survey on the socio-economic and environmental impact assessment of four community-based small-scale irrigation in the Upper Awash Basin of Ethiopia and concluded that rural credit systems, institutional support, monitoring of irrigation schemes, training in water management, marketing and general crop production, empowerment of local communities, economic evaluation of optimal plot size, cropping patterns, agronomic practices and resources utilized in the irrigation schemes were necessary conditions for viable and sustainable irrigation schemes. Further, he added that NGOs"s that are involved in irrigation development should come up with a clear, transparent and completed handing over up-graded or newly developed small-scale irrigation schemes to farmers. In addition, it has been established that a system of water user fees, which underwrite and reinforce the value of the resource and provide individual motivation for wise use, should be promoted.

FAO (1996) notes that irrigation expansion is vital to the health of the agricultural industry, improving the viability of individual farming enterprises, increasing the efficiency and economic viability of irrigation districts, and contributing to the economic and social objectives of the farming area and the country as a whole. Intensification of irrigation, the concomitant expansion of the irrigated area and the increases in agro-food processing will bring numerous direct and indirect benefits in the future (Barrett 1995).

Where irrigation performs poorly, failure is often attributed to an insufficient commitment to farmers, although clearly, this is not always the case. Cost recovery is adopted as a policy in most African countries because farmers will respond by increasing participation and exercising keener economic judgment on the construction and maintenance of irrigation infrastructure. Participation and commitment are closely linked, and it is argued that participation has no meaning unless commitment is an integral part of the outcome (Mutekwa and Kusangaya 2006).

Small-scale irrigation is often only one of several household income sources from agricultural activities besides rain-fed cropping and livestock activities (Brown & Nooter 1992). In most circumstances, it is only a part of the total land, and the household has access to what is being irrigated. The farmer's asset structure and entrepreneurial skill will influence the resource allocation to its different enterprises. Experience worldwide shows that particularly small irrigators usually grow crops under irrigation (Brown and Nooter 1992).

According to Makhura (2001), in the absence of an effective marketing system for their products and inputs, farmers do not have either the opportunity or the incentive to become productive as most of the farmers do not have their means of transport; they rely on contractors, taxis or neighbours and some expensive hired transport because of relatively small quantities of produce. These means are sometimes inaccessible because of the poor road network in most rural areas (Makhura 2001). The road infrastructure is deficient in some places, especially in KwaZulu- Natal and the Eastern Cape. As a result, there is a lack of market information and dissemination of such information, which is critical for small farmers' survival in the increasingly competitive marketing environment.

Fujile, Hayami and Kikuchi (2005) examined factors affecting the success and failure of collective action to manage local commons in developing economies using irrigation in the Philippines. The study was based on a cross-section survey of 46 irrigators' associations in 25 national irrigation systems under the command of the National Irrigation Administration over six provinces in the Philippines: Batangas, Cavity, Laguna, Occidental Mindoro, Oriental Mindoro and Quezon. The results of Probit and OLS regressions were consistent with the hypothesis that the collective action by water users for the operation and maintenance of irrigation systems is challenging to organize for the following reasons such as (a) where the water shortage rarely occurs, (b) where the difference in the water supply is significant between upstream and downstream farmers, (c) where irrigator's association is enormous in terms of the service area and the number of farmer-beneficiaries within its territory, (d) where the local community is sparsely populated, involving low social interactions, (e) where farm households have the option of a ready exit from farm to nonfarm economic activities and (f) where farmers had traditionally practised rain-fed farming with no previous experience in managing communal irrigation systems.

Shimelis (2006) evaluated the institutional and management practices of Small-scale Irrigation Systems in Ethiopia. He took the case of two small-scale irrigation systems in eastern Oromiya: Gibe Lemu and Gambela Terra. The result shows that the irrigation systems were poorly managed regarding water allocation and distribution, conflict management and system maintenance because of a lack of well-established organizational and institutional conditions. The water user associations are not well organized and found to be weak in running the irrigation systems. Users have problematic social relations. Clearly defined and well-enforced land and water rights are non-existent at the operational level. Regarding technical resources such as improved seed adaptive to irrigation, labour and knowledge of irrigated agriculture (extension service and capacity building for irrigators) have not been met in the two irrigation systems.

2.7. Relevance of Irrigation in Enhancing Employment and Income

The role of irrigation in increasing job opportunities and income has been studied and is significant (FAO, 2000). Irrigation, especially surface irrigation systems, is labour-intensive and requires more labour than rain-fed agriculture keeping other things unchanged. Therefore, irrigation can increase employment opportunities and income. This, in turn, enables access to food by improving purchasing power of individuals. Irrigation provides the chance to increase income. It is found that irrigation can increase income by creating more employment since it is labour-intensive. Irrigation can create or increase employment opportunities since surface irrigation is labour-intensive.

2.8. Socio-economic impact of Small-scale Irrigation

Impact studies differ in geographic coverage, scale of analyses, and approach adopted in measuring impacts (Hussain and Hanjira, 2004). Accordingly, the analysis scale varies among different studies, ranging from household to village, region, and national to international. Small-scale irrigation schemes may improve rural livelihoods compared to other African irrigation strategies if adequately implemented with appropriate technologies. However, the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara *et al.*, 2002).

Smallholders also require a broad range of support services (access to inputs, credit, and output markets), farming knowledge, and secure land tenure. For example, achieving economic viability in small-scale irrigation schemes on a market-oriented basis requires access to support services and opportunities for producing high-value crops.

2.9. Socio-Demographic factors affecting Small-scale Irrigation Schemes

2.9.1. Gender Role and Distribution

The household head may be a female or a male depending on cultural, social and economic circumstances. The household head is the one who makes decisions and coordinates the activities of the household (Pote, 2008). Therefore, the household head characteristics are significant as they define how the whole household operates; the head takes most decisions in the household, so the head has more responsibilities than the other family members. So it is essential to investigate the characteristics of the household head. For example, it is extensively believed that men are the ones who should be involved in farming more than women and that women should do housework as they have many responsibilities at home, which include taking care of the members of the family.

2.9.2. Age of respondent

Age is one of the most important factors in the individual's personality makeup since the needs and how an individual thinks are closely related to the number of years a person lived. According to Romuld and Sandham (1996), young people are more adaptable and willing than older people to try innovations since they believe in their old cultural way of doing things. However, Hofferth (2003) argues that older people have better experiences in agricultural activities than younger people because they know the social and physical environments better than younger people.

2.9.3. Dependency ratio

The dependency ratio shows the ratio of economically inactive compared to economically active. Economically active household members aged 15 to 64 are the household's principal income sources. Household members under 15 and over 65 are assumed to be

economically inactive and dependent on economically active household members for education, clothing and health care (John, 2002).

The dependency ratio of agricultural households provides planners and policymakers with an indication of agricultural labour 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, labour and/or financial constraints; that is, the dependency ratio is thought to be negatively related to the income of households (FAO, 2010).

2.9.4. Education of the household head

The years spent in formal education are essential determinants of increased agricultural production. Education catalyzes information flow and leads the farmers to explore the different pathways of getting information about agriculture and technology as widely as possible. Especially the use of modern technologies such as hybrid seeds, fertilizers and herbicides. The years spent in formal education are crucial in adopting new technologies (Ersado, 2001).

2.9.5 Family Size

Household size refers to the family members living in one house; the household size comprises adults and children. The household size determines the number of people involved in farming activities; having a large household size means having more people in the house. Thus, the household responsibilities are shared among all members of the house. The number of family sizes strongly correlates with other household resource endowments. For example, the family size directly relates to the landholding size and income of the family, though this is not always true in all cases. Family labour in traditional agriculture is the essential factor of production for increasing income and production and hence food security (Seid Yassin., 2002).

2.9.6. Employment status (occupation) of the household

The employment status of respondents clearly defines the time people have for farming; if a person is employed, then it means that they will have less time for agricultural production on their hands, and they will have to use the time they have after work for which by that

time they are very much exhausted. On the other hand, Pote (2008) notes that self-employed or not-employed people have more time for agricultural production; they can try out new production techniques and reap high yields.

2.10. Economic factors affecting Small-scale Irrigation Schemes

2.10.1. Household Income and Its Sources

A household's income is the total amount received from various sources and livelihood strategies. For example, a household's total income is derived from social grants, remittances, salaries, crop and livestock sales, and income from their jobs (permanent and casual jobs).

In standard production times, rural households' primary income sources are grain, selling smaller animals, seasonal employment and performing diverse income-generating activities. During harvest (November- December), the primary source of income is from selling crops relatively at a low market price. After the food stock from primary rain production is exhausted (usually around May and June), the primary source of income is from the sale of animals and diverse income-generating activities, including migration to towns and other areas.

The total household income has been divided into four groups depending on the source of the income generated. These include income from cash crop production, income from food crop production, income from livestock sales, and income from other sources. Only irrigation households generate income from cash crop production. In both cases, income from other sources refers to off-farm activities, including income from petty trade, wage Labourers, sale of firewood, eucalyptus poles, etc.

2.10.2. Livestock Holding

Livestock is the most important productive asset for households, both as a working tool (for ploughing and transporting) and as an asset to protect against periods of food shortage. The loss of livestock, especially ox, is critical as it ruins the asset base and impoverishes the general productive capacity of the households. Thus, livestock ownership is often used as an indicator of wealth. Small animals like sheep and goats play a significant role in rural households. Mostly they are sold to settle various household expenditures such as taxes, social obligations, etc., and to purchase food items in times of food shortage.

2.10.3. Landholding

Land is the major productive asset in agrarian countries like Ethiopia. Cultivated land appears to be a scarce essential factor of production. However, the land is one of agriculture's most important production factors. According to Altman *et al.* (2009), land is the primary input and factor of production, which is not consumed but without which no production is possible. Therefore, land ownership positively impacts agriculture since one has to access land to grow and produce crops for their household.

2.11. Institutional Aspect of the small-scale schemes

Irrigation development and management are social processes in which different stakeholders interact to make irrigation systems effective and efficient. Disappointing performances of government-owned and operated irrigation systems have compelled several countries to transfer rights and responsibilities for managing irrigation systems from government agencies to private or local persons or organizations.

According to Ostroms (2000:15), institutions for the governance of irrigation systems provide an analytical framework with three nested sets of rules necessary for the effective functioning of the irrigation system. The operational rules govern the daily use of monitoring water activities of others and rewards and sanctions for combining action and outcomes. Collective choice rules confirm how schemes should be operated and managed. Constitutional choice rules determine who can participate in a scheme and draw up the operational and collective choice rules.¹⁸⁾

To bring this up, Poven (2004) pointed out that WUAs are the most frequently recommended organizational form for managing irrigation schemes. This is because WUAs are legal entities with complete control over their scheme's irrigation infrastructure.

2.11.1 Access to Extension Services

Extension agents visit farmers in rural areas to advise on what they need to be advised on and provide them with information on the new production techniques to add to their technical know-how. The extension is the mechanism by which information and technologies are delivered to farmers (Moris, 1991). The World Bank as a 'process that

helps farmers become aware of improved technologies and adopt them to improve their efficiency, income and welfare' in Gebremedhin and Pedon (2006) give a more comprehensive definition of extension service. Extension services in Ethiopia until 2002 focused on increasing production and productivity because of achieving food security. However, most farmers are illiterate and cannot read the information in printed form. Thus, DAs need to disseminate agricultural information to farmers through other means. In-country like Ethiopia, where most farmers are illiterate, agricultural extension plays a more significant role in identifying and analysing their production, raising awareness, and seizing opportunities to make informed decisions. Hence, the effectiveness of various production inputs partly relies on agricultural extension service opportunities at community levels. According to Van Den and Hawkins (1988), the main aim of the extension program is to initiate change to bring about sound agricultural development, especially for smallholder farmers. It offers them technical advice and supplies with the necessary inputs and services. Agricultural extension is, therefore, used as a tool for rural development.

2.11.2. Accesses to Market Centers and Market price Information

Marketing is the pivot of economic development in rural areas. It is essential to income and employment generation in farm and non-farm sectors. Broadly, rural marketing incorporates the marketing of agricultural products, rural industries products, and services of many kinds. Good market concentration and communication systems are crucial to a well-functioning agricultural marketing system; producers require information to improve market efficiency and reduce transaction costs. Conversely, poor concentration and Unequal access to price information can give a competitive advantage to particular groups of producers or traders.

The principal weaknesses in the marketing system are market information deficiencies, infrastructure and remoteness to market centres, which raise the cost of transportation. The magnitude of these deficiencies may differ across regions and countries. However, the most visible effect of these weaknesses creates a large spread between the prices producers are paid for their produces and the retail prices. Proximity and access to market centres at a shorter distance like that of the research site create additional income by providing irrigational income generation opportunities, access to farm inputs, better prices

for agricultural outputs, and better conditions for households. This provides a chance for irrigators to' perfect interaction for sellers to sell their produce directly to consumers with less or no transport cost coverage. It was, therefore, expected that households significantly closer to market centres have a better chance to diversity and sells their products to first-channel traders at lower transport cost and create better market access to the produced crops, especially for the perishable and high-value crops, which might make the farmers cultivate more crops and increase their income. (Mintesinot *et al.*, 2004).

2.11.3. Access to Input Supply and Utilization

People get farming inputs mainly from the government in the municipality, agriculture, and social development in the rural area. This is because the government has developed a new strategy to support and develop projects in rural areas. The government is trying to bring together all the departments to develop rural areas to work together. People can get inputs from the government and previous harvests and buy inputs from local markets. Proper utilization of modern inputs such as improved seeds, chemical fertilizers, pesticides, and fungicides is fundamental to any farm enterprise, especially in high-value horticultural crops. However, the efforts to develop efficient and effective technologies have achieved limited success in small-scale farmers, who are often regarded as resistant to changes (Sands, 1986). Some researchers have attributed small-scale farmers' failure to adopt improved technologies partly to the inadequacy of support systems, such as extension services, credit, and input supplies. All farmers apply fertilizers and pesticides. Click here (<https://www.youtube.com/watch?v=v1DT4yvxpMw>)

2.11.4. Access to Credit

According to Kebede (1995), credit makes traditional agriculture more productive by purchasing farm equipment and other agricultural inputs, introducing a modern irrigation system and other technological developments. Credit can also be used as an instrument for market stability. Rural farmers can build their bargaining power by establishing storage facilities and providing transport systems acquired through credit. Credit plays a crucial

role in covering the consumption deficits of farm households. This would, in turn, enable the farm family to work efficiently in agricultural activities. Credit can further be used as an income transfer mechanism to remove the inequalities in income distribution among small, middle, and big farmers. Moreover, credit encourages savings and savings held with rural financial institutions that could be channelled to farmers for agricultural production.

2.11.5. Membership in Water Users Association

Each irrigation scheme is a common property resource owned and managed by the community. Each site has formed Water Users Association (WUA), which Water Users Committee administers (WUC). Under normal circumstances, everybody who is the beneficiary of irrigation water is a member of WUA in a particular scheme. WUA is a local institution and has a primary character of authority and by-laws. It has rules, methods, and sanctions for selecting an executive committee, raising finances, settling disputes among irrigation water beneficiaries, and supervising the irrigation water service.

In many developing countries, the management of irrigation schemes is transferred from the government to WUAs to reduce the transaction cost associated with their management (Easter and Zekri, 2003). Therefore, WUAs are the most frequently recommended organizational forms for irrigation management. The associations are supposed to have complete control over the irrigation infrastructure in the territory they serve. However, problems with underfinancing operations and Maintenance and investments are observed due to incomplete decentralization processes.

2.12. Psychological factors that affect Irrigation Utilization

2.12.1. Causes of conflict over irrigation water utilization

There is insufficient water in the system at peak times to allow all the farmers to undertake their desired farming activities at particular points. Allocating water for farmers ensures a reliable and timely water supply, allowing as many of them as possible to undertake the appropriate farming activities. Competition for water is also the most significant cause of conflicts among water users; again, allocating water is a way to resolve this. In general,

allocation schedules are only implemented when water is scarce. Click here (<https://www.youtube.com/watch?v=aFO4h8i-h6g>)

At other times, farmers can take water as and when they like. This is important to farmers as they like to see a constant water supply to their fields and keep the required water level in the basins. Therefore, top-end farmers will only follow an allocation schedule if they see a problem in the furrow's middle reaches and tail end. There are three critical periods in the crop cycle when water scarcity can occur. Firstly, if the rains are late, there can be intense water competition when farmers transplant in December and January. Secondly, there is intense competition if a long (two to three week) break occurs during the rainy season, which often occurs in January. The third period is when the rains diminish, and tail-end crops are still at the growing stage. This is a particular problem if the rains finish early. Access to water during these three periods depends on a farmer's relative position along a furrow. Those at the top end receive water first, and those at the tail end receive water last. For example, top-end farmers plant their nursery fields in October and can harvest as early as April. At the same time, farmers at the tail-end plant their nursery fields in December or January and do not harvest until July.

2.13. Conceptual Framework of Irrigation Utilization Analysis

Many related pieces of literature were reviewed to select the factors affecting the utilization of small-scale irrigation schemes. A literature review on the concept of irrigation indicated that irrigation utilization was affected by socio-demographic, economic, institutional, and psychological factors at the household level. Based on the review of related literature, the researcher made frequent visits to the study area since it was the work area of the researcher and the significant factors that affect irrigation utilisation was also supported by the literature review results of different researchers' work. Therefore, the researcher analyzed the influence of independent variables on dependent variables in the Ella small-scale irrigation scheme utilization based on the below-mentioned conceptual framework

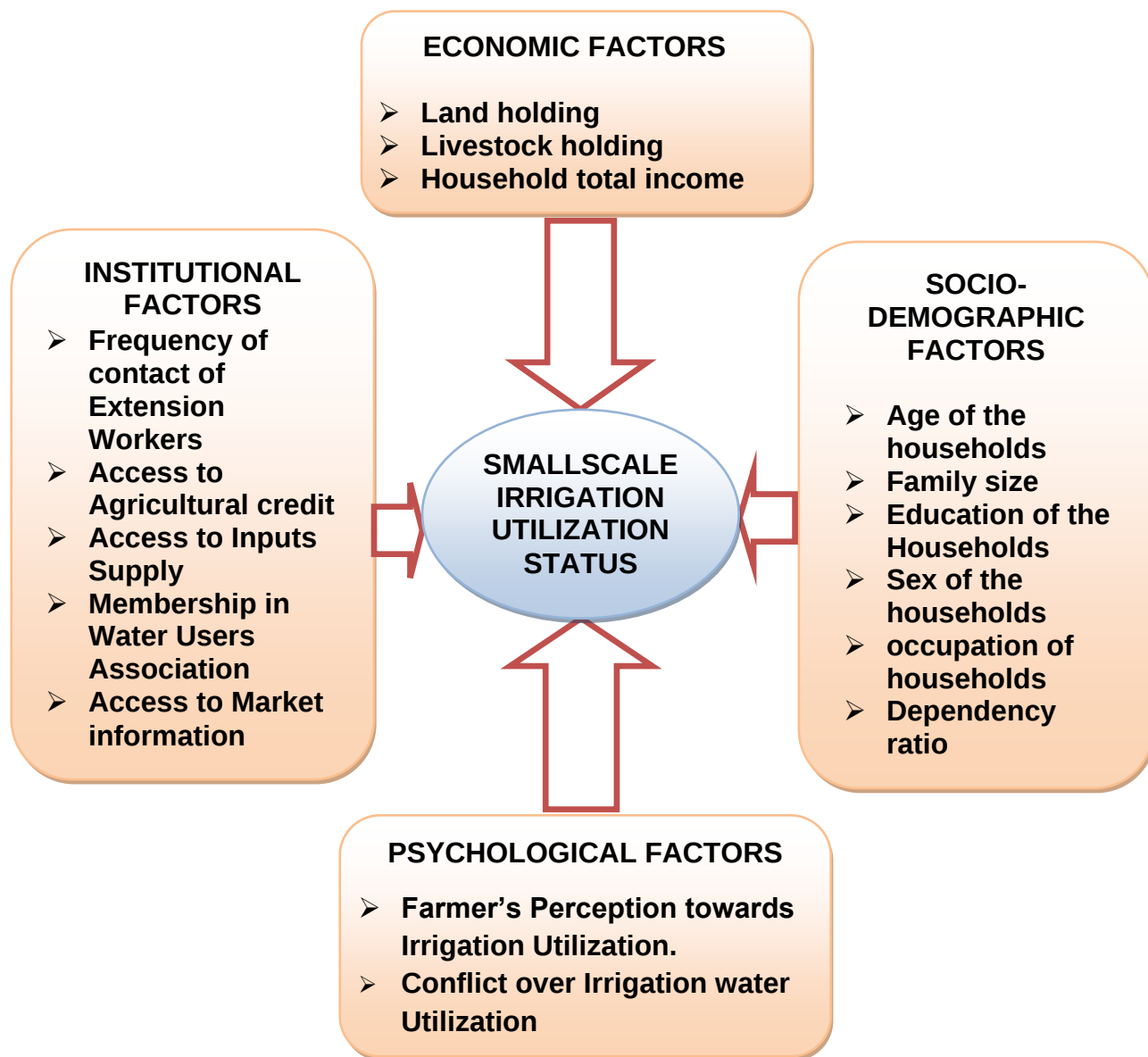


Figure 1: Conceptual Framework of the Study

Source: Based on the available works of literature

CHAPTER III

3. METHODOLOGY

3. METHODOLOGY

3.1. Description of the Study Area

The study Woreda Humbo, which is latitudinal 37°40"E and 38°00"E and longitudinally 6°45"N to 6°30" N in highly degraded Woreda. The elevation of the Woreda is 1,070m to 2353m above sea level. The total population of Woreda is 152,495, with a density of 167 persons/ km². (Eshete,1995).

The woreda has a total area of 86,646ha. Of this, 70% is Woyna Dega agro-ecology, and 30% is Kolla agro-ecology. 80% of the people who live in rural areas are engaged in agriculture, mainly a mixed farming system. Land shortage, erratic rainfall, severe land degradation, high deforestation and frequent drought are the prominent feature of the woreda. The land is now insufficient, less productive, and less healthy. There is widespread erosion, nutrient depletion and loss of water resources, the more significant subdivision of the land, giving rise to micro-holdings and micro-agriculture; the problem affects the ecology of the area and the productivity of agriculture in general, i.e. crop and livestock production where 93% of the zone population depending upon its survival.

The effects of these problems have resulted in shallow soil depth, very poor fertility of the soil, disturbance of natural balance, i.e. loss of vegetation and wildlife, low production and productivity of the land and food insecurity at the household and community level that resulted in the migration of some community members to other places.

The problem affects the area's ecology and agriculture production in general, i.e. crop and livestock production, which most community members depend upon for survival.

3.2. The Ella Small-Scale Irrigation Scheme

The Ella small-scale irrigation scheme is established by diverting water from the Hamasa River in Ampho Koysha Kebele of the Humbo district. The river has an estimated discharge of 250 lt/sec. The Government and Community developed the irrigation scheme in 1985. The initial capacity of the irrigation scheme is an area of 100 hectares with a gravity flow of water. With this capacity, the irrigation scheme is supposed to benefit 206 households in the district.

3.3. Sample size and Sample Procedures

An important decision to be taken while adopting the sampling technique is determining the sample size. Appropriate sample size depends on various factors relating to the subject under investigation, like time, cost, degree of accuracy, etc. If the sample is too small, it might be challenging to achieve the objectives of the analysis. However, too large may result in resource wastage when dealing with the sample to miss some helpful information about the population.

As a result, several approaches were often used to determine the sample size. Approaches more often utilized include using Census for small populations, imitating a sample size of similar studies, using published tables, and applying the formula to calculate the sample size. To determine sample size, the researcher used the population proportionate sampling method from 872 household heads who lived in the study area, 206 were irrigators, and the remaining 666 were non-irrigators. From 206 irrigators, 24 households were selected, and from 666 non-irrigators household heads, 76 were selected. To select the sex of the households, the researcher employed a simple random sampling method; from 24 irrigating households, eight were Female head households, and 16 were male head households. Of 76 non-irrigating household heads, 28 were female household heads, and 48 were male.

The sampling procedure followed for this study was a Multi-Stage Sampling Procedure. Firstly, Humbo was selected as they are identified as one of the food insecure Woreda in the Wolaita Zone and the place where the scheme was constructed. Then, out of a total of 41 kebeles found within Humbo Woreda, one kebele, namely Ampho Koysha, was also selected purposively considering the factor of the presence of the Ella SSI scheme, and they are the most beneficiary out of the water of the scheme. Finally, the selection of the study area, i.e. Humbo district and the scheme site, was carried out purposively because of the relative accessibility of the district and the site.

In the second stage of the sampling procedure, a stratified random sampling technique was employed to determine the sample frame of the study, which was used to select sample household heads within selected Kebele, a list of household heads with a separate

sheet of users of the constructed irrigation scheme, was obtained from respective Kebele Administration and Agricultural Extension Office.

Then, in the third stage, sample household heads from irrigation users and non-users were selected using proportionate population sampling considering the total sample determined for the Survey. Therefore, this study was conducted on 100 households as representatives of the total population in the study area, with irrigation users as only part and non-users as a control group for comparison purposes. The rationale for selecting the two groups (Users and Nonusers) from study Kebele was to minimize heterogeneity except for irrigation access.

3.4. Sampling distribution

Table 1: Sample size distribution in sample Peasant Administrative (PAs)

S, No.	Category of respondents	Sex	Household size	PPS	SRS
1	Irrigators	Male	174		16
		Female	32	24	8
	Subtotal		206		24
2	Non –irrigators	Male	486	76	48
		Female	180		28
	Subtotal		666		76
	Total		872		100

Source: research compilation

Pictorial form of the Sample size determination

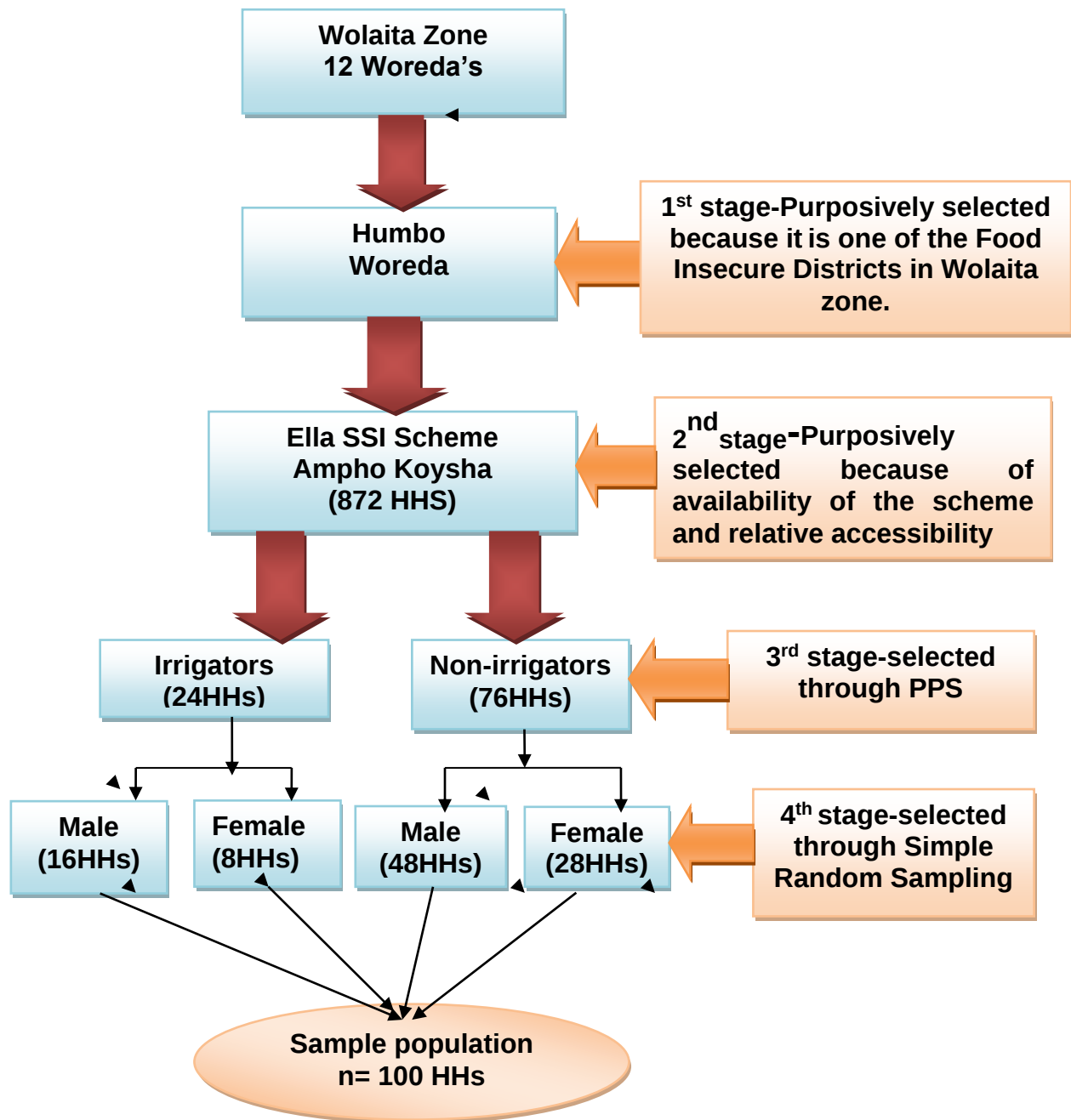


Figure 3: Sampling Procedure

3.5. Data type and source

This study collected qualitative and quantitative data from primary and secondary sources.

3.5.1. Primary Data Sources

Research tools such as Key Informants Interviews (KII), Focus Group Discussions (FGD) and Interview Schedules with Checklists were employed to generate the required primary data from different primary sources. These techniques are used to collect data that belongs to household Socio-demographic, Economic, Institutional and Psychological factors that affect irrigation schemes.

3.5.2. Secondary data

Secondary data was gathered from various sources like Zonal and District Offices of agriculture and rural development, NGOs serving in World Vision and the like. For example, zonal and district water office, Finance and Economic Development, Department and offices of Agriculture and Rural Development, Cooperative, Land management and natural resources). Similarly, research publications and other published and unpublished sources were also referred to and consulted to enrich information.

3.6. Method of data collection

In the study, both primary and secondary data were utilized using quantitative and qualitative methods. Consequently, the following instruments were used in this study to collect the best quality data: An interview Schedule with the sample HHs, and a checklist for the FGD and Key Informant Interview.

3.6.1. Interview Schedule

In the survey research, the conventional Interview schedule was the primary method to collect quantitative data from household heads. A carefully designed Interview Schedule consisting of interrelated questions were employed and administered by semi-trained enumerators. Sample household heads are the unit of analysis from whom quantitative information was collected.

Three enumerators were employed to conduct the interview schedule under the close supervision of the researcher. The enumerators were Development Agents in Irrigation Scheme and Kebele. Before launching the survey, enumerators were briefed about the survey and familiarized with the Interview Schedule. Development Agents were chosen as

enumerators due to their knowledge and acceptance among the community, which helps the researcher fill the Interview Schedule adequately.

3.6.2. Focus Group Discussion

Using a checklist comprising open-ended questions specifically prepared for each group of the target community and the overall situation of the study area was asked to get various socio-economic facts. It enabled triangulating or substantiating the secondary and Interview schedule data generated on the current situation of small-scale irrigation schemes, challenges that farmers have faced in irrigation activity and the contribution of irrigation to food production supplements in the study area.

Three Focus Group Discussions were conducted with selected participants. The first FGD was undertaken with a community representative, whereas the second and third FGDs were held with irrigation users and non-users. On average, 11 people participated in the group discussions. In selecting participants, an attempt was made to include different population segments such as Kebele leaders, Kebele Council members, elders, Development Agents, members of the association of irrigation water users, women and irrigation users and non-users, and youth farmers were included.

3.6.3. Key Informants Interview

The qualitative Interview was conducted using a checklist with ten Key informants. The informants for the researcher were Development Agent (DA) working in the study Kebele, District officials pertinent to irrigation issues (Irrigation Desk Officer, Head for Cooperative promotion office, from Woreda Administration, a person in charge of economic and rural development, District Irrigation Extension Service, District Agricultural Office and Cooperative office). Generally, stakeholders on integration toward sustainability and development of small-scale irrigation schemes were assessed.

3.7. Method of Data Analysis

After data was collected from primary and secondary sources, it was analyzed using different data analysis methods. Before analysis, quantitative data gathered using the

Interview Schedule was coded and entered into statistical software known as SPSS (Statistical Package for Social Sciences) version 16, 2003. The data was processed and then cleaned.

For the quantitative data, both descriptive and inferential statistics techniques of data analysis were used. Descriptive statistical techniques such as mean, percentage, and standard deviation are used for presenting differences in socio-economic variables in data analysis. Specifically, SPSS software was used to analyze most of the quantitative data collected in the survey. The strength and direction of a linear relationship between two variables were analyzed using a correlation coefficient. In addition, inferential statistics techniques of data analysis such as Independent sample T-test and analyzing the data generated through household interview schedules were employed. An Independent Sample T-test was applied to compare the income and other rural assets of the respondents who did not participate in the small-scale irrigation scheme.

The study employed the Binary Logistic Model to analyse the data to identify the factors that affect the utilization of the scheme and investigate the effect of variables on the utilization of the Small-scale Irrigation Scheme.

3.7.1. Statistical Tools to be applied

The study employed descriptive, inferential statistics and a Binary Logistic model. The descriptive analysis was performed using frequencies, means, and maximum and minimum values. Inferential statistics, such as the T-test for continuous variables and the chi-square test for the dummy variables, measure the significance of independent variables on the dependent variable. The econometric analysis employed the Binary Logistic Model to analyse small-scale irrigation schemes on productivity with, among others, irrigation utilization influencing factors.

In general, this study focused on analysing small-scale irrigation scheme utilization. However, several studies interlinked the area or issue with Socio-demographic, Economic, Psychological, and institutional factors. Thus, there was a need to have an appropriate model consisting of all data dimensions required to develop a relevant conclusion or outcome. Therefore, specifications from the three model types, such as liner, logit, and

prohibit, have been considered for deciding the model, and the dependent variable irrigation utilization decision, dichotomous and independent, has been considered.

Pinyack and Runbinfield (1981), cited in Teshome, 2010, logit and prohibit the most frequently used when the dependent variable is dichotomous (Gujarati,1992). As a result, this study selected the logit model for analyzing the data because it is easier to calculate; the functional form of the logit model used in this study is presented as follows

$$P_i = E\left(\frac{Y_i}{x_i}\right) = \frac{1}{1 + e^{\beta_0 + \beta_1 x_1}} \dots \dots \dots (1)$$

$$P_i = E\left(\frac{Y_i}{x_i}\right) = \frac{1}{1 + e^{-z_i}}$$

Where P_i is a probability of irrigation utilization not influenced by independent for i^{th} irrigation utilization and ranges from zero to one, Z_i is a functional form of m explanatory variable (x_i), which is expressed as

$$Z_i = \beta_0 + \sum_{i=1}^m \beta_i x_i, (i = \text{one, 2, and 3} \dots m) \dots \dots \dots (2)$$

Where β_0 is the intercept and β_i is the model's slope parameters. The slope tells how the log odds in favour of irrigation utilization change as independent variables change. For example, suppose P_i is the probability of irrigation utilization influenced by the explanatory variable. In that case, one – P_i indicates the probability of utilization does not change when the independent variable changes, which can give us:

$$1 - p_i = \frac{1}{1 + e^{z_i}} \dots \dots \dots (3)$$

Dividing equation (1) by equation (3) and simplifying it gives

$$Ez_i = \frac{p_i}{1 - p_i} = \frac{1 + e^{z_i}}{1 + e^{-z_i}} \dots \dots \dots (4)$$

Equation (4) indicates the odds ratio indicated irrigation utilization changed when the explanatory variable changed. It is the ratio of the probability that users are influenced to the probability of not being influenced. Here, one represents those affected and 0 otherwise. Lastly, the logit model is obtained by taking the natural logarithm of equation (4) as follows.

$$Li = \ln = \frac{p_i}{1 - p_i} \beta_0 + \beta_1 x_i$$

Where P_i = the probability that $Y = 1$ (the event occurred or probability of growth);

$1 - P_i$ = the probability that $Y = 0$ (the event does not occur or not affected);

L_i = the natural log of the odds ratio or logit

B_i = the slope measures the change in L (Logit) for a unit change in explanatory variables (X);

B_0 = the intercept. It is the value of the log odds ratio, $\frac{p_i}{1+p_i}$ When x or explanatory Variable is zero. Thus, if the stochastic disturbance term (u_i) is taken into consideration, the logit model

Becomes $L_i = \beta_0 + \beta_1 X_1 + U_1$ (6)

The dependent variable of this study is irrigation utilization. Irrigation utilization is influenced by independent variables, as observed in the result and discussion.

3.8. Definition of Variables and Working hypothesis

Once the analytical procedures and their requirements are known, it is necessary to identify the potential explanatory variables and describe their measurements. Accordingly, the key variables expected to influence the utilization of small-scale irrigation schemes, as explained below.

3.8.1. Dependent Variable:

The dependent variable of this study was the utilization of the small-scale irrigation scheme with dummy values of one for households which is irrigators, and zero for that non-irrigator in the scheme study Kebele in Humbo district.

3.8.2. Definition of Explanatory Variables

The independent variables include socio-demographic factors such as the educational level of the household head, sex of the household head, age of household head, family size, occupation of households, and Dependency ratio. Institutional factors like access to market centres, access to credit services, access to input supply, Membership in WUA, Economic factors such as total cultivable land holding, livestock holding, the total income of the household, crop production and psychological factors such as farmers perception

towards the utilization of the scheme and conflict among users. Details of the independent variables and hypothesized relationships are presented below.

3.8.2.1. Socio-Demographic Factors

Age of the household head (AGEHHH): This is a Continuous variable that measures the age of the household head in years. As the age of the household increases, they can acquire more knowledge and experience in farming and pre-assume vulnerability and risk conditions of food insecurity. Furthermore, household heads influence most choices of crops to be grown; hence, aged farmers will be perfect in terms of decision-making preference. Thus, the household head's age was hypothesised to affect the irrigation scheme's utilisation positively.

Sex of the household head (SEXHHH): This is a Dummy variable with one household head male values and 0 otherwise. Due to unequal access to resources and decision-making between male and female household members, the irrigation scheme's utilisation decision was also assumed to differ between male and female-headed households. Therefore, this study hypothesized a negative relation between the sex of the household head and the utilization of the scheme.

Educational Level (EDULEVEL): This is a Continuous variable measured in formal schooling years completed by the household head. Most previous studies indicated that the possibility of adapting and applying new farming methods increased along with education level. Accordingly, this variable was hypothesized to influence irrigation schemes' utilisation positively. Therefore, it is expected to affect irrigation utilization decisions positively. Furthermore, households with a better education level are believed to have a chance to apply scientific knowledge. As a result, they better manage their farm activities exemplary, boosting domestic production to fulfil household consumption needs.

Family size (FAMSIZE): This is a Continuous variable measured in the total number of household members living under the same roof. Due to the positive and negative relationship between household size and the utilization of agricultural technologies by previous empirical studies, this study did not hypothesize the relationship between household size and utilization decision in the small-scale irrigation scheme.

Dependency ratio (DEPRATIO): This variable was measured as the ratio of the household member not in the labour force, child or old, to those household members in the labour force. The dependency ratio reflects the pressure and responsibility on a household member in the labour force. Hence, this variable will be hypothesized to have a negative relationship with the utilization of the small-scale irrigation scheme, i.e. as the dependency ratio increase, the participation decreases in the irrigation scheme decreases and vice versa. Household members aged below 15 and above 64 are considered dependent and divided by household members aged between 15 – 64, resulting in a dependency ratio. These groups are economically inactive and become a burden to other household members to fulfil their immediate food demands. Therefore, it was hypothesized that dependency ratio and irrigation utilization decision are negatively related.

Occupation of household head (OCUHHH): This is a Dummy variable measured with values of one of the household head's primary occupations: farming and zero otherwise. Those households with agriculture as their primary occupation were assumed to utilise the small-scale irrigation scheme more than those with primary non-agricultural occupations. Hence, this variable was assumed to affect the participation decision in the irrigation scheme positively.

3.8.2.2. Economic factors

Total cultivable land size (CULTLAND): This is a Continuous variable measured in hectares, and it refers to the total land size the household cultivated. In the Gorogutu district, most households were smallholder farmers and the only possible way to increase the output level was by increasing the productivity of the land. Hence, this variable was hypothesized to positively affect a household's food security and contribute to the irrigation utilization decision.

Livestock holding (LIVESH0): Livestock ownership is essential not only for income generation but also as a saving option or proxy for household physical assets and risk management mechanisms. Besides, in a mixed farming system, livestock is a source of draught power, buffer stock and milk production. Therefore, this variable was hypothesized to negatively affect the irrigation utilization decision of the household heads in the study

area. This was mainly because; those farmers with large livestock holdings were expected to better off their food security status and focus on livestock-related enterprise than irrigation-based crop production.

Total income (TINCOME): This is a Continuous variable measuring the household's total income obtained from farming (livestock and/or crop production), off-farm as well, as Non-farm activities. The livelihood of most rural households in rural Ethiopia relies on agriculture, and the income level obtained from this sector helps to determine their food stands the poverty status. Therefore, this variable is assumed to negatively affect the study area's utilisation of small-scale irrigation schemes. In other words, those household having more farming income were less likely to utilize the irrigation scheme. Non-farm income is one income source for any household member participating in non-farming activities and generating an income in Birr. It was assumed that farm income earned by a household is primarily spent on food items such as food grains and non-food items required for household members. Therefore, in this study, it was hypothesized that non-farm income is negatively associated with the irrigation utilization decision of household heads.

3.8.2.3. Institutional factors

Access to Market (ACCESMAR). This variable is a Dummy variable as one, access to market and zero otherwise affecting the irrigation utilization decision of household heads. The farther the market centre is, the lesser the income from the sale of farm produce. Especially for perishable commodities, if the market is located far away from the farm, the commodity may perish before arriving at the market, forcing the farmer to sell his product at a lower price; this affects the household income negatively. Therefore, distance from the market centre was hypothesised to affect the irrigation utilization decision negatively.

Access to Credit (ACCCRE). This variable is a Dummy variable. Credit access is precious for purchasing improved seeds and other essential inputs. Hence, farmers who have access to credit would positively affect the utilization of irrigation schemes and hence produce crops due to agricultural inputs, which enhance food production and ultimately increase the income that indicates the direct relationship between credit and irrigation utilization decision.

Membership in Water Users Association: It is a Dummy variable; if the household is a member, the value takes one and zero otherwise. It hypothesized that membership in the water users association has positively influenced the irrigation utilization decision of farming households. The association was established to settle a dispute among irrigation users' households.

Inputs Supply (INPUSUP): the capability of farming households to use the inputs such as fertilizer and improved yield varieties for their agriculture, non-farming, and off-farming activities. It has been expected that the better input utilized by farming households in irrigation schemes produces more food and is more food secure than those that are not using it (Adugna, 2012).it hypothesized that there is a positive impact of input supply and utilization on crop production and availability of food on the household level.

Access to Extension Service (ACCEXTES): the frequency of visits of agricultural extension to farming households can determine households' participation in the irrigation scheme. Hence, it is expected that frequent extension contact received will increase the tendency of the household to participate in scheme utilization.

Extension service plays an essential role for rural farmers in terms of providing advice and information. In addition, training is a valuable service to introduce and develop modern technologies (proper types and fertiliser rates, improved varieties of seeds, agro-chemicals, etc.) Hence, those households who participated in a training organized at FTC or farm demonstration are supposed to apply their knowledge to increase farm production. Thus, households would be in a better position for food security status.

3.8.2.4. Psychological factor

Farmers Perception (FARPER): this variable is Dummy; if the household head has a positive perception, it takes 1 and 0 otherwise. Farming households perceive that irrigation utilization results in soil erosion and water-borne diseases, making them produce low production and costing much for medication. Therefore, the farmer's perception negatively affects the utilization of small-scale irrigation schemes.

Conflict over Water Utilization (CONFLIT): this variable is Dummy if the household head response is 1 for the cause of conflict, overutilization of irrigation scheme is water

insufficiency, 2 for response unequal distribution, and 3 for mismanagement. The quarrels among the members of the Water Users Association will reduce irrigation water usage for cultivation purposes and settle disputes among users. Therefore, this variable is hypothesized to influence the scheme's utilisation negatively.

Table 2: Summary of Explanatory Variables, Expected effect and Results

S.No	Variable Definition	Variable Type	Expected Effect	Results
1	Age of the HHHs (AGEHHH)	Continuous	Positive	NS
2	Sex of the HHHs (SEXHHH)	Dummy	Negative	NS
3	Educational level of the HHHs (EDULHHH)	Category	Positive	Positive
4	Family size (FAMSIZ)	Continuous	Positive	Positive
5	Dependence ratio of the HHHs (DEPRATIO)	Dummy	Positive	NS
6	Occupation of the households (OCCUHH)	Dummy	Positive	Negative
7	Land holding of HHHs (LAHOHH)	Continuous	Positive	Positive
8	Livestock holding of HHHs in TLU (LIVHOL)	Continuous	Negative/positive	Positive
9	Total household income (TOTINCOME)	Continuous	Negative	NS
10	Access to Market Information (ACCMARIN)	Dummy	Negative	NS
11	Access to Credit (ACCCRE)	Dummy	Positive	NS
12	Member of Water Users Association. (MEMWUA)	Dummy	Positive	Not known
13	Access to Input supply (ACCEINUSUP)	Dummy	Positive	Positive
14	Frequency of Extension Agent contact (EXTENS)	Dummy	Positive	Negative
15	Farmers' perception towards irrigation utilization(FARPER)	Dummy	Negative	NS
16	Conflict over irrigation water utilization(CONFLIT)	Dummy	Negative	Negative

Source: research compilation, 2014

CHAPTER IV

4. DATA ANALYSIS AND RESULTS

4.DATA ANALYSIS AND RESULTS

This chapter reports the valued findings of the research. The chapter is divided into two main sections. The first section presents the survey findings based on descriptive statistics, mainly frequency, mean, standard deviation, and the percentages employed in analysing the survey results. The second section presents the econometric analyses and tests the scientific significance of independent variables against the dependent variable. The binary logistic model was used to test results accordingly.

4.1. Results of Descriptive Analysis

4.1.1. Socio-Demographic Variables

This section discussed the respondents' gender, age, family size, occupation, dependency ratio, and highest educational levels. These aspects are essential because the household head coordinates the main household activities, and the head's decisions are most likely influenced by such demographic aspects (Makhura, 2001). This section describes the analysis of survey data and its interpretation. In the first section, the sample household demographic characteristics are discussed. The utilization of a small-scale irrigation scheme is influenced by the variables such as the age of the household, family size, education level, sex of the household, and occupation of the household for irrigating and non-irrigating. These descriptive analyses help to frame the econometric results obtained in the study.

Table 3: Sex of the sample respondents

Sex	Irrigator (N=24)		Non –Irrigator (N=76)		Total (N=100)	
	No	%	No	%	No	%
Female	8	33.3	28	36.85	36	35.05
Male	16	66.7	48	63.15	64	64.9
Total	24	100	76	100	100	100
χ^2 value = 0.097				P-value = 0.755		

Source: Survey Data, 2014

NS: Non-significant probability level.

In the study area, the head of the household is generally responsible for coordinating household activities. Therefore, it is pertinent to examine the attribute sex of the head as one component of irrigation participation decisions. Out of the 100 sampled households, about 64.9% were male-headed, and 35.05% were female-headed households. The percentage of irrigating female household heads was more than Non- irrigating (Table 3). The χ^2 - test result witnessed no significant difference in the sex of the sampled household heads for irrigating and non-irrigating households. Therefore, irrigation utilization decisions and the sex of household heads have no relationship.

Table 4: Age of Sample household heads

Age of HHs (Years)	Irrigator (N=24)		Non- irrigator (N=76)		Total (N=100)	
	Mean	Std.	Mean	Std.	Mean	Std.
	45.8750	6.75221	47.4079	7.06197	47.0400	6.98616
Minimum						32
Maximum						70
T-value = 0.977				P-value = 0.351		

Source: Survey Data, 2014

NS: Non-significant probability level.

The household heads of sample respondents ranged from 32 to 70 years, with a mean of 45.8750 and a standard deviation of 6.75221 years for small-scale irrigation users. For non-users respondents, the mean and standard deviation are 47.4079 and 7.06197 years, respectively (Table 4). However, the age difference between the two groups is statistically insignificant, suggesting age has very little influence on the irrigation utilization participation decision.

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. However, there is no significant difference in the distribution of household head age of the sampled households between irrigating and non-irrigating household heads. (Table 4).

Table 5: Educational status of sample households' head

Educational level						
of sample HHHs	Irrigator (N=24) Non-irrigator (N=76)				Total (N=100)	
	No	%	No	%	No	%
Illiterate	0	0	18	23.7	18	11.85
Grade 1-4	11	45.8	29	38.1	40	41.95
Grade 5-8	10	41.7	22	28.9	32	35.3
Grade 9-10	3	12.5	7	9.2	10	11.75
Above Grade 10	-	-	-	-	-	-
Total	24	100	76	100	100	100
Mean						1.2900
SD						0.93523
X² value = 7.070				P-value= 0.070*		

Source: Survey Data, 2014

*, Statistically significant at less than 10% probability level

Education plays a key role in the household decision on technology adoption. It creates awareness and helps for better innovation and invention. The study revealed that none of the users and 23.7% of the non-users of small-scale irrigation were illiterate. It is also found that the per cent of irrigation users who completed grade 8 years of schooling and above is two times greater than non-users. Since economic growth is driven by the change in people's capabilities or their human capital, as affected 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 the adoption of irrigation technologies to improve agricultural productivity (Maddison, 1970). The education level of household heads is higher for irrigating households than in non-irrigating households (Table 5.). This shows that the education level of households significantly affects irrigation schemes' utilisation at a 10% probability level. ($p < 0.070$).

Table 6: The family size of Sample Households

Family size	Irrigator (N=24)		Non-irrigator (N=67)		Total (N=100)	
	No	%	No	%	No	%
0	4	16.7	27	35.5	31	26.1
1-4	11	45.8	46	60.5	57	53.15
5-9	5	20.8	3	3.9	8	12.35
Above 10	4	16.7	0	0	4	8.35
Total	24	100	76	100	100	100
Maximum					10	
Minimum					1	
Mean					0.8500	
SD					7.2995	
T-value = -4.401			P-value= 0.000***			

Source: Survey Data, 2014

***, Statistically significant at less than 1% probability level

Household size refers to the total number of families living in one house; the household size comprises adults and children. The household size determines the number of people involved in farming activities; having a large household size means having more people in the house. Thus, the household responsibilities are shared among all members of the house. Family size helps formulate various development plans and monitor and evaluate their implementation. The average family size at Ethiopia's national level was 4.7 (CSA, 2007).

In the study area, the average family size was 0.8500, with a minimum of 1 and a maximum of 10. The t-test shows a significant difference in family size between the irrigating and non-irrigating households at a 1% significance level (Table 6). This result is statistically significant, suggesting labour availability is an essential factor influencing households' decision to participate in small-scale irrigation schemes. The result also revealed that as active family labour or workforce of a household in adult equivalent increases, the total income of the household increases, which in turn contributes to improved well-being and food security status of households, further providing evidence for the importance of labour availability in influencing the participation decision of households in small-scale irrigation.

Table 7: Dependency Ratio

Dependency Groups						
	Irrigator (N=24)		Non-irrigator (N=76)		Total (N=100)	
	No	%	No	%	No	%
<15 age	24	100	63	82.9	87	91.45
15-64 ages	0	0	8	10.5	8	5.25
>64 age	0	0	5	6.5	5	3.25
Total	24	100	76	100	100	100
Mean						1.1800
SD						0.50010
χ2 value = 4.719				P-value= 0.094*		

Source: Survey Data, 2014

*, Statistically significant at less than 10% probability level

From the above table, the dependency ratio shows the ratio of economically inactive compared to economically active. Economically active household members, whose age is from 15 to 64, are assumed to be the principal sources of income and productive labour. Household members under 15 and over 65 are assumed to be economically inactive and dependent on economically active household members for education, clothing and health care (John, 2002).

The average dependency ratio was 47.35% in the study area, which means that every 100 economically active persons had 47 extra persons to feed, clothe, educate, and medicate. Economically active members (5.25percent) were less than non-active household members (47.35%). A statistically significant difference was observed between irrigating and non-irrigating households for the dependency ratio at the 10% probability level (Table .7).

Table 8: The occupation of sample household heads:

Occupation of Household Heads	Irrigators (N=24)		Non-Irrigators (N=76)		Total (N=100)	
	No.	%	No.	%	No.	%
Engaged in non-agriculture	0	0	0	0	0	0
Engaged in agriculture	10	41.7	52	68.4	62	55
Engaged in both agriculture and non-agriculture	14	58.3	24	31.6	38	45
Total	24	100	76	100	100	100
χ^2 value = 5.542				P-value= 0.019**		

Source: Survey Data, 2014

**, Significant at less than 5% probability level.

In the table above, the majority, 55% of household heads, were engaged in agriculture. The remaining 45% of household heads were engaged in agriculture and non-agricultural activities. 41.7% of irrigators and 68.4% of non-irrigators were engaged in agriculture, 58.3% were irrigators, and 31.6% of non-irrigators household heads were engaged in both agriculture and non-agricultural activities. As χ^2 -value witnessed, household heads' occupations have statistically significant, with the participation of household heads in irrigation utilization at less than 5% ($p < 0.019$).

4.1.2. Economic Factors

Table 9. Livestock holding of sample household heads

Livestock holding in TLU	Irrigators (N=24)	Non-Irrigators (N=76)	Total (N=100)
Ox	18	28	46
Cow	12	31	43
Bull	34.5	42.6	76.6
Heifers	38.5	22.5	61
Calves	16.3	21.4	37.7
Goat	48.4	120.45	168.85
Sheep	12.5	24.32	36.82
Donkey	2.6	6.4	9
Horse	0	0	0
Mule	0	0	0
Weaned calf	31.4	42.24	73.64
Chicken	8.43	11.65	20.08
Total	222.63	350.56	573.19
Mean	7.5353	3.8009	6.3030
SD	3.09355	1.04182	3.13773
T- Value = -4.760		P-value= 0.000***	

Source: Survey Data, 2014

***, Significant at less than 1% probability level.

The study area type is settled agriculture with a mixed farming system (i.e., integrated crop and livestock production). Livestock is the most important productive asset in the household. In the study area, livestock is a significant power source for ploughing. It is also considered a saved asset used during periods of food shortage. The average livestock holding for sample households was 6.3030 TLU. Irrigating households possess a more significant average number of livestock (7.5353 TLU) than non-irrigating households

(3.8009TLU). There is a significant difference between irrigating and non-irrigating households at the 1% significance level (Table 9).

Table 10: Landholding size of household heads

Land holding Size(ha)	Irrigators (N=24)		Non- irrigators (N=76)		(Total (N=100))	
	No	%	No	%	No	%
0.25ha	1	4.1	55	72.3	56	38.2
0.5ha	11	45.8	20	26.3	31	36.05
0.75	7	29.1	0	0	7	14.55
1ha	5	20.8	1	4.1	6	12.45
2ha	0	0	0	0	0	0
Total	24	100	76	100	100	100
Minimum					0.25	
Maximum					1	
Mean					0.3257	
SD					0.13552	
T-value = -9.191			P value = 0.000***			

Source own survey, 2014

*** Significant at the 1% Probability level.

Land is the major productive asset in agrarian countries like Ethiopia. Cultivated land appears to be the scarce essential factor of production. In the study area, the average landholding size of the sample households is 0.3257 ha, three times less than the national land holding of 1.0 hectares. There is a significant difference between irrigating and non-irrigating households in average land holding size at a 1% significant level (Table 10).

Irrigating households have a larger cultivated land area than non-irrigating households. Therefore, irrigation may generate income and allow the accumulation of other productive assets by irrigating households, facilitating more crops for feeding the household members and selling to the market, especially those market-oriented crops and vegetables in non-irrigating households. The difference between them is statistically significant at the 1 % significance level. Therefore, the landholdings of the household heads have a positive relationship with the utilization of irrigation schemes.

Table 11: Mean household income in Ethiopia Birr of household heads

Mean household income portfolios of the farm households in Ethiopian Birr					
Source of income		Users (N=24)	Non-users (N=76)	T-value	p-value
On-farm	Irrigation	234.79ETB	0.00	13.284	0.000***
	Rain-fed	875.58ETB	699.00ETB	2.230	0.028**
	Irrigation and rain-fed	322.35ETB	699.00ETB	13.027	0.000***
	Livestock	139.08ETB	379.52ETB	24.625	0.000***
Total		571.8ETB	1777.52ETB	15.704	0.000***
Off-farm		289.58ETB	289.73ETB	-0.003	0.000***
Non-farm		260.00ETB	266.55ETB	-0.224	0.823(NS)
Total		838.74ETB	233.38ETB	15.514	0.000***

Source: Survey data, 2014

***, **, NS, Statistically significant at less than 1% and 5% and Non-Significant, respectively

The survey results found a significant difference in mean total household income between irrigation users and non-user livelihoods. Based on the above table 1, the mean total income of household heads from the on-farm income of irrigation users was 1571.8ETB, and non-users household heads were 1777.52ETB. The off-farm income of irrigation users was 289.58ETB, and non-users were 289.73 ETB. Non-farm income is also ETB 260.00 and ETB 266.55 for users and non-users, respectively. These indicate that irrigation users have less income from on-farm and non-farm activities than non-users. However, irrigation users and non-users households had similar income sources in off-farm activities. On-farm income refers to the total income from irrigated, rain-fed, irrigated and rain-fed crops and livestock production.

Similarly, off-farm income is a type of income derived from sources such as the trading of agricultural products. The t-value results confirmed a positive and significant relationship between households' on-farm and off-farm income and irrigation utilization at less than 1% and 5%, respectively. The positive effect between on-farm and off-farm household income and utilization of irrigation farming suggests that income derived from on-farm activities

enables households to pay for farm inputs required for profitable irrigation farming. However, irrigation farming has negatively influenced off-farm income, suggesting that households engaged in off-farm activities are less likely to participate in irrigation farming. Nevertheless, higher market prices of irrigation products will likely motivate farm households to participate in small-scale irrigation schemes.

4.1.3. Institutional Factors

Table 12: The frequency of extension contact by the household head

Frequency of Extension contact		Irrigators (N=24)		Non-irrigators (N=76)		Total (N=100)	
		No	%	No	%	No	%
Weekly	18	75	23	30.2	41	52.6	Fortnightly
0	0	35	46.	35	23	Monthly	6
18	23.7	24	24.4				25
Total	24	100	76	100	100	100	100
T –value= 2.397				P-value = 0.018**			

Source: Survey data, 2014

**, Significant at less than 5% probability level.

From table 12, it is revealed that out of 35 respondents with a distribution of 23 %, extension agents visit once a fortnight. The extension agent visits 24 respondents with a distribution of 24.4 % once a month. 41 respondents out of the total number of 100 respondents, with a distribution of 52.6 % that extension agent visit weekly. This shows that extension agents in the area visit weekly, a fortnight and a month, respectively. This is good because many people are to be serviced, and there are limited extension workers. They helped Irrigators (75%) more than they helped Non-irrigators (30.2%) in providing technical assistance. Extension agents' role in providing improved crop varieties and practical training to innovative farmers was crucial. There was a significant association between the frequency of extension contact between irrigation users and non-users' household heads. According to the T-test, this variable's result is significant at less than a 5% probability level. (p<0.018).

Table 13: Access to Market Information by the Sample household heads

Access to Market Information	Irrigators (N=24)		Non- irrigators (N=76)		Total (N=100)	
	No	%	No	%	No	%
No information at all	3	12.5	8	10.5	11	11.5
Telephone	11	45.8	46	60.5	57	53.15
Person to person	0	0	7	9.2	7	4.6
Access to transportation	10	41.7	15	19.7	25	30.7
Total	24	100	76	100	100	100
χ^2 value= 6.475			P-value=0.091**			

Source: Survey data, 2014

** Significant at less than 5% probability level.

The main reason for the variation between Irrigation users and Non-user households in their community position is the access and utilization of information. Information on market prices and channels is one of the important aspects of the livelihood improvement of rural farm households. Although the information on the marketing of irrigation products and agricultural inputs is a determinant factor for producers, only 43.7% of the irrigation users and 40.1% of non-users have access to information. As a source of information, 45.8% and 60.5% of irrigation users and non-users household heads used a telephone (mobile), respectively. In addition, 41.7% of users and 19.7% of non-users have access to transportation, respectively. In addition, the remaining 0% of users and 9.2% non-users household heads have access to transportation for direct market information. Therefore, irrigation users and non-users households better utilise modern means of communication like mobile. The χ^2 value result indicated that access to market information positively affects irrigation utilization decisions and knowing the exact price in the market it sold. It is statistically significant at less than a 5% probability level, and positive relationship between access to market information and irrigation utilization since items produced through irrigation water were more market-oriented and profitable than those produced by rain-fed agriculture. ($P < 0.091$).

As data collected from Focus Group Discussion and Key Informant Interviews supported the statistical result above. 95% of interviewers from focus group discussion and 80% of Key Informant Interviewers responded that information in the marketing of irrigation products and agricultural inputs is a determinant factor for producers, only 75.4% of the

irrigation users have access to information. As a source of information, most of them used the mobile telephone as a source of market information. The remaining household has access to transportation and person-to-person communication, respectively. Person-to-person information sharing is information transfer from individuals who see and hear the markets that day or a day before and tell others orally. This shows that even delay and outdated information is challenging, as price changes are volatile with unfixed time limits.

Table 14: Membership in Water Users Association by the household heads

Membership in Water						
	Users Association Irrigators (N=24)		Non-irrigators (N=76)		Total (N=100)	
	No	%	No	%	No	%
Yes =1	24	100				
No =0	0	0				
χ^2 value = 1.000			P-value=0.000***			

Source: Survey data, 2014

***, Significant at less than 1% probability level.

As Table 15 indicated, the entire irrigating household heads were the Water Users Association members. This institution has the right to manage the equal utilization of the irrigation scheme among the users. They provided the solution if the conflict exists between those upper streams and lower stream users. Therefore, the household was motivated to utilize the scheme and cooperated since they have a legal institution that safeguards the proper and fair utilization of the scheme. The χ^2 -test indicated that the Water Users' Association membership and irrigation utilization are statistically significant at less than a 1% probability level.

Discussions with Key Informants and FGD revealed that before establishing the Water Users Association, many irrigating household heads would settle their conflicts through informal channels by taking their complaints about mediation by tribal elders or sub-village chairpersons.

This conflict resolution method was not considered the fair and equal utilization of irrigation schemes among users and led to unwanted human costs for the households. This is because of the lack of sense of believing each other, and no harmonious relationship exists. It was also reported that Irrigation users and household heads farmers never took their disputes outside their communities but preferred to settle them according to the common law they produced.

Table 15: Access to Input Supply by Sample household heads

Access to Input Supply	Irrigators (N=24)		Non-irrigators (N=76)		Total (N=100)	
	No	%	No	%	No	%
No Access to input supply=0	2	8.3	35	46	37	27.15
Access to input supply=1	22	91.7	41	54	63	72.85
Total	24	100	76	100	100	100
χ^2 Value =11.133	P=0.001***					

Source: Survey data, 2014

**, Significant at less than 1% probability level.

The above table16 shows that out of the total 24 Irrigators' household heads, only 22 (91.7%) and out of 76 non-irrigators household heads, only 41 (54%) had access to Input Supply from Government credit institutions, and 2 (8.3%) of Irrigators household heads and 35 (46%) of Non-Irrigators household heads were lack of access to the input supply. The access to input is one factor that motivated the Irrigators' household heads to utilize the scheme for better production and ensure their livelihood. The χ^2 -value result revealed that the access to input supply and irrigation utilization decision were statistically significant at less than a 1% probability level ($p < 0.001$)

The following results from Key Informant Interviews and FGDs have been discussed that due to lack of Credit Access to purchase enough inputs, the period of supply of agricultural inputs miss-match with the farming season, and sometimes the price of input supply was skyrocketing, at the high-interest rate charged with and the size of land they have minimal and can only be covered by compost manures, forced input supply and the household losing assets to pay back with interest forcing the utilization bottleneck etc. Therefore, due to the abovementioned factors, the farming households were not motivated to utilize the inputs, and food production s were also affected.

4.1.4. Psychological variables

Table 16. Farmers' Perception towards the utilization of the Irrigation Scheme

Farmer's perception towards The utilization of the Irrigation Scheme						
	Irrigators (N=24)		Non-irrigators (N=76)		Total (N=100)	
	No	%	No	%	No	%
Positive =1	24	100	73	96	97	98
Negative =0	0	0	3	4	3	2
Undefined	0	0	0	0	0	0
Total	100	100	76	100	100	100
χ^2 value = 0.977			P-value=0.323(NS)			

Source: Survey data, 2014

NS: Non- significant.

From table 17 above, we can see the farmer's perception of the utilization of the Irrigation Scheme understudy was 98% positive, and the remaining 2% negatively perceived irrigation. From both Users and Non-users, household heads were not responded undefined as their response. The χ^2 -result revealed that the utilization of irrigation schemes and household heads' perception is statistically non-significant.

The finding from the Key Informants Interview (KII) and Focus Group Discussion (FGD) show that the reason irrigating households and non- irrigating households have a positive perception were that irrigation minimizes the risk of erratic rainfall and the dependence of farming households on rainfall as well as irrigation making the users to produced crops twice in a year. Furthermore, some of the Non-irrigating household heads perceived that irrigation degraded the topsoil and reduced fertility by washing out when it was drained to farm plots. Those households who lived around the irrigation scheme perceived that insect was spread in the scheme area, which was the leading cause of the spread of malaria, forcing them to spend on medication expenses.

Table 17: The Causes of Water use conflicts among household heads

Causes of water use conflict	Irrigators (N=24)		Non-irrigators (N=76)		Total (N=100)	
	No	%	No	%	No	%
Water insufficient	18	75	37	48.7	55	61.85
Unequal water distribution	4	16.7	19	25	23	20.85
Water mismanagement	2	8.3	20	26.3	22	17.3
Total	24	100	76	100	100	100
χ^2 value = 5.528 P-value=0.063*						

Source: Survey data, 2014

*, Significant at less than 10% probability level.

Table 18 shows that the majority of the respondents, 55 (61.85%), responded that the main cause of conflict over water utilization was water insufficient, followed by 23 (20.85%), and 22 (17.3%) responded that unequal water distribution and water mismanagement were the causes of conflict over-irrigation scheme utilization respectively. The χ^2 -value revealed a statistically significant difference between Irrigating and Non-irrigating household heads' responses to the causes of conflict in water utilisation in the Irrigation Scheme at less than a 10% probability level. There this variable is significantly affecting the utilization of the scheme. ($p < 0.063$).

Key Informant Interview and FGD discussed that conflict over water use signifies water scarcity in the community. This contributes much to increased food insecurity due to insufficient crop production. This implies that water could be applied to the cultivated land at the right time and quantity if it was well managed in its use and distribution. Proper management of this practice could improve crop yield, household income, and food security. The scheme serves those Kebeles downstream. As a result, the volume of water is decreasing, and water utilization has its schedule among Upper, Middle and Downstream users.

Table 18: The Major Challenges for not effective Utilization of the Irrigation Scheme

Major Challenges	Irrigators (n=24)	Non-irrigators (n=76)	Total N= (100)	Rank
High cost of purchasing Agri. Inputs	23	24	47	1 st
Lack of efficient extension support	18	21	39	2 nd
Marketing problem	14	17	31	3 rd
Poor irrigation method practice	18	12	30	4 th
Poor crop selection/pattern	12	13	25	5 th
Lack of provision of improved seeds	9	6	15	6 th
Poor canal management and cleaning	3	7	10	7 th
Transportation problem	6	3	9	8 th
Pest and disease occurrence	4	3	7	9 th
Weed problem	3	2	5	10 th

Data source: own survey, 2014

As Table 19 shows, the significant challenges in effectively utilising the Irrigation Scheme by farming households in the study area were the high cost of purchasing agricultural inputs, lack of efficient extension support, market problems and poor irrigation method practice. The remaining factors, like poor crop selection patterns, lack of provision of improved seeds, poor canal management and cleaning, transportation problem, pest and disease occurrences and weed problems, were also affecting the efficient utilization of the scheme, respectively.

4.2. Summary of the Descriptive Statistics (Discrete Variables)

The summary of the descriptive analysis part of this study bridges the findings from descriptive or quantitative analysis and analyses the qualitative results (FGD, Personal Interviews and researchers' observations). In the descriptive analysis, part 16, Independent Variables were hypothesized to affect the dependent variable, i.e. Irrigation utilization decision in Ella Small Scale Irrigation Scheme. Table 20 and Table 21 below present the summary of the hypothesized Continuous and Discrete variables included in the model.

Out of the total 10 Dummy variables, seven variables were significant. The Occupation of household heads, access to input supply and access to market information were significant at less than a 5% probability level. Dependency ratio and irrigation Water Users Association membership were significant at less than a 1% probability level. The other four, i.e. dependency ratio of household heads, Education level of household heads, Access to market information of household heads and Conflict over irrigation water, were significant at less than a 10% probability level. The rest of the discrete variables were insignificant, such as the Sex of household heads, Access to credit, and the Farmers' Perception of the Irrigation Scheme utilisation.

Table 19: Summary of the result of Dummy Explanatory Variables

Dummy Variables	χ²-value	P-value
Sex of HHHs	0.554	0.457(NS)
Educational level of HHHs	7.072	0.070*
Dependency ratio	7.973	0.005***
Occupation of HHHs	5.542	0.019**
Access to credit	1.629	0.202(NS)
Access to input supply	6.505	0.011**
Membership in WUA	1.000	0.000***
Access to market information	6.475	0.091**
Farmers' Perception towards the utilization of the scheme	0.977	0.323(NS)
Conflict over irrigation water utilization	5.528	0.063*

Source: Own Survey, 2014.

Note: ***, **, *, NS: Significant at less than 1%, 5%, 10% and Non-significant probability level respectively.

4.3. Summary of the Descriptive Statistics (Continuous Variables)

Five revealed a significant effect on the Irrigation Utilization decision from the six Continuous variables. Family size, land size, livestock holding, and household head income were significant at less than a 1% probability level. The rest of them are Frequency of extension contact was significant at less than a 5% probability level. The other, the age of the household head, was non-significant.

Table 20: Summary of the result of Continuous Explanatory Variables

Continuous	Variables	t- value	p-value
	Age	0.977	0.351(NS)
	Family size	-4.401	0.000***
	Land size	-9.191	0.000***
	Frequency of extension contact	2.397	0.018**
	Total income of HHHs	15.514	0.000***
	Livestock holding	-4.760	0.000***

Source: Own Survey, 2014.

Note: NS, ***, **, Non-Significant, significant at less than 1% and 5% probability level, respectively.

4.4. Econometric Analysis

Factors affecting the utilization of Small-scale Irrigation Schemes by the farming households

In this part of the research, econometric analysis was carried out using the data collected from the randomly selected sample of 100 farming households in the study area. The dependent variable was the dichotomous choice variable with two categories (0 for Non-irrigators and 1 for Irrigators). With the Binary Logistic Regression (BLR) model's application, the explanatory variables hypothesized as influencing the factors in the Utilization of Irrigation Schemes were regressed. The analysis was done using a statistical software package, 'SPSS Version-16'.

The Contingency Coefficient, which measures the association between various Dummy variables based on the Chi-square, was computed to check the degree of association among the Dummy explanatory variables or the existence of the multi-collinearity problem.

4.4.1. Multi Co- linearity diagnosis

The factors affecting Small-scale Irrigation Utilization by farming households and data collected from 100 farmers fit into logistic regression analysis. The statistical software used for analyzing the data was SPSS 16.0 for windows. Before running the logistic regression model, the Continuous and Discrete explanatory variables were checked for a multi-

linearity problem. The problem arises when at least one of the independent variables is a linear combination of the others. The existence of multi-co-linearity might cause the estimated regression coefficients to have the wrong signs and smaller t-ratios, leading to wrong conclusions.

Two measures are often suggested to test the presence of multi-co linearity. First, the variance Inflation Factor (VIF) is for association among the continuous explanatory variables and contingency coefficients for dummy variables Gujarati (2003).

The Variance Inflation Factor (VIF) technique was employed to detect multi-co linearity among the continuous variables. According to Gujarati (2003), VIF can be defined as:

$$\text{VIF}(x_i) = 1 / (1 - R_i^2)$$

The square of multiple correlation coefficients results when one explanatory variable (X_i) is regressed against all other explanatory variables. The larger the value of $\text{VIF}(x_i)$, the more “troublesome” or collinear the variable X_i is. As a rule of thumb, if the VIF of a variable exceeds 10, there is a multi-co-linearity problem. The VIF values displayed below (Table 21) have shown that all the Continuous explanatory variables have no serious multi-co linearity problem.

Similarly, contingency coefficients were computed to check a multi-co linearity problem among the discrete explanatory variables. The contingency coefficient is computed as:

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

Where C= Coefficient of contingency,

χ^2 = Chi-square random variable and

N = total sample size.

The decision rule for Contingency coefficients is that when its value approaches 1, there is an association problem between the Discrete variables.

Table 21: Contingency Coefficient for the Dummy Variables of Binary Logit Regression

	Sex	Educational level	Dependency ratio	Occupation	Access to Credit	Access to Market	Access to Input Supply	Farmers' Perception	Conflict over Water Utilization
Sex	1	0.126	0.000	-0.168	0.165	-0.051	-0.009	0.000	0.076
Educational level		1	0.000	-0.161	0.124	-0.037	0.062	0.000	0.104
Dependency ratio			1	0.000	0.000	0.000	0.000	0.000	0.000
Occupation				1	0.137	-0.097	0.088	0.000	0.013
Access to credit					1	-0.107	-0.219	0.000	-0.059
Access to market						1	-0.006	0.000	-0.063
Access to input supply							1	0.000	0.035
Farmers' perception								1	0.000
Conflict over water utilization									1

Source: Own survey, 2014

Based on the above Contingency coefficient results, only membership in Water Users Association was not correlated with all Dummy variables. The remaining Dummy variables were correlated. The contingency coefficient, which measures the association between various dummy variables based on the Chi-square, was computed to check the degree of association among the dummy explanatory variables or the existence of the multi-collinearity problem. The decision rule for the contingency coefficient states that its value of 0.75 or above indicates a stronger relationship between the explanatory variables.

Table 22: Variance Inflation Factor (VIF) for the Continuous Explanatory Variables

Variables	Tolerance	Variance Inflation Factors(VIF)
Age of HHHs	0.503	1.987
Family Size of HHHs	0.745	1.343
Landholding HHHs	0.695	1.438
Livestock holding HHHs	0.669	1.494
Total income of HHHs	0.530	1.887
Frequency of Extension contact	0.822	1.216

Source: own survey, 2014

As shown above, in table 23, the values of the VIF for the six Continuous variables were small (i.e. value less than 10), indicating the data have no serious problem of multi-collinearity. As a result, all six continuous variables were retained and encoded into binary logistic regression analysis.

4.4.2. Model Output

The preceding section identified variables characterizing the farm households and their differences among the User and Non-user groups. However, in the logit model analysis, we emphasize considering the combined effect of variables between Irrigation users and Non-user farm households in the study area. Therefore, the emphasis was on analyzing the variables together, not one at a time. We can incorporate vital information about their relationship by considering the variables simultaneously.

Sixteen variables were hypothesized to explain the factors affecting farming households' utilization of the Irrigation Scheme. Out of these, Eight of the variables were significant. At the same time, the remaining Seven were less significant in explaining the variations in the dependent variable, and one variable did not show variation among sample farm households.

The maximum likelihood estimates of the logistic regression model show that the significant factors influencing the utilization of Small scale Irrigation Scheme by the farming households were the educational level of households, livestock holding of households, family size of households, landholding of households, frequency of extension contact, access to input supply, occupation of households and conflict over irrigation water utilization. The results presented in Table 25 were discussed in more detail. For this study,

the discussion focused on the significant variables in the table. One of the study's specific objectives is to investigate the challenges encountered by farming households in utilising the Small-scale Irrigation Scheme. The response variable is whether farmers can utilise irrigation schemes for better products and more yields. (Table 25).

The variables like Sex of household heads, age of household heads, dependency ratio, farmers' perception, access to credit, access to market and total income of the household heads were inability to explain the factors affecting the utilization of the Irrigation Scheme. In addition, the variable membership in Water Users Association did not vary among sample farm households. For this reason, it was not retained in the model.

Table 23: Definition of Model Variables

Dependent Variables	Variable Definition of Measurement if the
Irrigation Utilization	Households Irrigation Utilization Status are:
$P_1 = 0$	Non-irrigators
$P_2 = 1$	Irrigators
Independent variables	
SEX	Sex of the Household Head
AGE	Age of the Household Head
EDUL	Educational level of the Household Head
LIVEHO	Livestock holding
FASIZE	Family size
TOTCUL	Total cultivated land
EXTENS	Frequency of Extension contact
ACCCRE	Access to Credit
DEPRATIO	Dependency ratio
ACCEINPUSUP	Access to Input supply
ACCEMARINFO	Access to Market to Information
TOTINCO	Total Income
MEMIWUA	Membership in Water Users Association
OCCUHH	Occupation of the Household Heads
FAPERC	Farmers' perception of the utilization of irrigation scheme
CONFLIT	Conflict over the utilization of the irrigation scheme

Table 24: Parameters Estimation of Binary Logistic Regression on the Irrigation Utilization Status of the farming households Ella Small scale Irrigation Scheme

Dependent Variable Y=0,Y=1	Explanatory Variables	Coefficient (β)	Std. Error	Wald	P-Value Sign.	Odds ratio {(Exp(β))}
	SEX	0.154	0.494	0.097	0.755	1.167
	AGE	-0.033	0.035	0.879	0.348	0.968
	EDUL	0.561	0.276	4.118	0.042**	1.752
	LIVEHO	0.450	0.118	14.519	0.000***	1.569
	FASIZE	1.404	0.404	12.098	0.001***	4.071
	LANDHO	10.406	2.368	19.307	0.000***	3.307
	EXTENS	-0.777	0.340	5.210	0.026**	0.460
	ACCECRE	0.606	0.478	1.606	0.205	1.833
	DEPRATIO	-19.209	8.497	0.000	0.998	0.000
	ACCEINPSU	2.240	0.774	8.382	0.004***	9.390
	ACCEMARINFO	0.328	0.233	1.975	0.160	1.388
	TOTINCOME	0.123	0.143	0.748	0.387	1.131
	OCCUHH	1.110	0.482	5.300	0.021**	3.033
	FARPERC	20.090	2.321	0.000	0.999	5.311
	CONFLIT	-0.803	0.360	4.963	0.026**	0.448
	Constant	74.178	2.513	0.000	0.998	1.641
	Observations: 100					
	Horner & Limeshow					
	Test:chi-sqaure	0.000				
	: Significance	1.000				
	-2log likelihood	110.216				
	ratio					
	Cox &Snell R ²	0.688				
	Negelkereke R ²	1.000				

Note: ***, indicates significance at 1%, **, indicates significance at 5%.and NS: indicates Non-significant. Source: own survey, 2014

4.5. Summary of Quantitative Analysis

The results of the logistic regression discuss the results of the significant variables determining the decision of households whether or not they utilized the Irrigation Scheme. All the variables discussed in the previous sections were considered for the model and tested for their significance. The binary logistic results are presented in Table 26 shows the estimated coefficient (β values), standard error, significance values and odd ratio of the independent variables in the model.

The results of the omnibus test of model coefficients were significant with $P > 0.000$ with a chi-square of 110.216. The chi-square value for the Hosmer and Lemeshow test is 0.000 with a significance level of 1.000. This value is more significant than 0.05, indicating support for the model. The model as a whole is explained between zeros. 688 (Cox and Snell R square) and was insignificant ($p > 0.05$), suggesting that the model fit the data well. In other words, a non-significant Hosmer and Lemeshow chi-square statistic indicated that a model had a good fit and 1.000 (Nagelkerke R square) the irrigation utilization decision of the farmers.

Educational level of the farming households

Education is significant at a 5% significant level with a positive effect on the Irrigation Utilization decision of households; with the increased level of education of the households, the probability of utilizing the Irrigation Scheme for their crop production increased by 1.752 as compared to those who are not in a good level of their educational status to utilize Irrigation Scheme for their production. Education level is one way of mental development; well-educated farming households quickly adopted modern technologies and practised new production methods than those uneducated farming households. Therefore, education and irrigation utilization decisions were positively correlated at less than a 5% significant level.

Family Size of the households

The household's family size was an important variable in deciding to utilize the Irrigation Scheme for two or three times the production of crops and vegetables for home consumption and market. The Wald statistics corresponding to the variable FAMSIZE

show that it is significant at less than a 1% probability level. The odds ratio favouring the Irrigation Utilization decision increases by 4.071 for farming households with a large family size because irrigation agriculture needs a vast labour force for the cultivated crop with high value and highly demanded markets. Therefore, the Irrigation utilization decision is positively correlated with family size. As a result, family size is significantly affecting the Irrigation utilization of farming households.

Livestock holding of the Farming households

The number of livestock was measured using a tropical livestock unit (TLU) in rural areas, which constitutes accumulation of wealth, security against emergencies, and gifts and is used as a cultural privilege. They can also be easily converted into cash when the demand arises. Due to these reasons, it was hypothesized to have a positive relationship with the dependent variable by justifying that as the total number of animals in the household increase, the household would be more likely to rear animals to gain income as a side of crop production and highly motivated to utilize the Irrigation scheme and practised modern ways of production by the fulfilling forage gap of animals during the dry season. This can be attributed to an increase in the wealth and income base of the farm households, which makes more money available. The result of the logit model also revealed that the variable has a positive relationship that farmer with a more significant number of animals' uses the Irrigation Scheme than those with lesser animals. The odds ratio favoured the irrigation utilization decision increases by a factor of 1.569 for households with a more significant number of animals. The result is consistent with the prior expectation.

Total cultivated land by Farming households

It was also evident from the results that total landholding (TOLAHO) would increase the Irrigator's probability. This may imply that Irrigators intensify their cultivated land while rain-fed farmers try to put more land left following. The odds ratio favoured Irrigation utilization increases by a factor of 3.307 for households with larger cultivated farms than those with lesser farms. The positive relationship between cultivated land size and Irrigation utilization decision is that farmers who cultivate a more extensive land size can utilize more capital

for labour and other farm inputs and earn a more considerable income. Therefore, this will increase the Irrigation utilization status of the farming households.

Frequency of Extension Contact by Farming households.

Frequency of Extension Contact (EXTENS): Contradicting the initial hypothesis, this variable was found to have a negative effect and significant at less than a 5% probability level. The odds ratio favouring the irrigation utilization decision decreases by a factor of 0.460 as the frequency of extension contact increases by one visit. Therefore, the frequency of contact between extension workers and irrigation utilization has been negatively correlated.

Access to Input Supply

The use of chemical fertilizer and high-yielding varieties was found to correlate positively with the irrigation utilization decision of the farming households. It significantly affects the irrigation utilization decision of the farming households at less than a 1% probability level. Furthermore, when the access to Input Supply is increased by one unit, the irrigation utilization decision is improved by 9.390. Therefore, irrigation utilization decisions and access to input supply have positively correlated.

Occupation of the Farming households

The occupations of the households were factors that determined household income diversification. Contrary to the prior hypothesis, this variable was found to have a negative effect on the Irrigation utilization decision of the farming households and was significant at less than a 5% probability level. The odds ratio favouring the irrigation utilization decision realized that the effect of other factors was constant. The irrigation utilization decision by farming households failed to improve by 0.033 with the increasing occupation of the farming households. Therefore, Irrigation utilization decisions and the occupation of households have negatively correlated.

Conflict over Irrigation Scheme Utilization among Farming Households

The conflict over Irrigation scheme utilization was the main challenge among the irrigation users households. In the prior hypothesis, this variable was found to have a negative effect

on the irrigation utilization decision by farming households and was significant at less than a 5% probability level. However, the odds ratio revealed that the irrigation utilization decision of the households failed by 0.448%, with an increase of one unit of conflict among the scheme users in farming households. Therefore, irrigation utilization decisions and conflict over scheme utilization have negatively correlated.

4.6. Summary of Qualitative Analysis

(Focus Group Discussion and Key Informants Interview)

Education level of the Sample Household Heads

Education is one of the means of developing humans mentally; the educated house heads were quickly adopting new technology and utilizing Small scale Irrigation for their productivity more than those uneducated household heads. The utilization of the small-scale Irrigation Schisthey actively involved in keeping irrigation canal from damage and siltation in solving conflicts among us by tough participating in different committees that uneducated household heads.

Family Size of Households heads

Family size refers to the total number of household who is living in one house; since irrigation farming needs a large labour force, those household heads who have significant family sizes could utilise irrigation water in high amounts for production than household heads who have small family sizes, In contrarily, for those household heads whose family members were composed of younger and old age group, the chance to actively involved in irrigation farming for productivity was less than household composed from adult age groups.

Livestock holding Household Heads

In the study area, the agriculture type is mixed (crop production and rearing livestock); the major problem for rearing livestock in the study area is the lack of sufficient forage and enough grazing lands. The households were utilizing irrigation water better off land size and plant grasses for their livestock forage than those non-utilizers of irrigation water. Since water is available year-round, they are planting different grasses, which

Development Agents advise. Due to the above cases, the livestock holding of irrigators is greater than Non-Irrigators.

Total Cultivated land by farming Household

As land is one of the significant assets for rural farming households. Those households with access to irrigation water (Irrigators) are better off cultivating their entire farmland than non-irrigators because irrigating households can produce crops twice or more without waiting for rainfall and generate income for the well-being of their households. Therefore, they were not left land following but instead used it for productivity rather than for non-irrigating household heads.

Frequency of Extension Contact

The extension agents are the main body of agricultural-based development in providing the necessary advice to utilise irrigation water for productivity. If the extension agents are frequently visiting farming households to support farming household ability and skills to practice irrigation water for crop production increases from time to time, the reverse is also true. The continuous follow-up by extension workers (agents) should encourage farming households to effectively utilise irrigation water to produce high-value crops for themselves and the market.

Access to Input supply by farming Household

Input is vital for soil fertility and a high yield of productivity. Those households that have access to input are more productive than no access. In the study area, both irrigating and non-irrigators have equal access to input, but in terms of utilization status, irrigators were better than Non-Irrigators. Irrigators produced crops without waiting for rainfall. As a result, they produced high-value and market-oriented crops, generated better income than Non-irrigation, and could pay credit on time.

Occupation of the Farming household

In the study area, the primary occupation of farming households in agriculture. In addition to agriculture, they were also involved in petty trading. Therefore, those households whose primary occupation was agriculture spent much of their time farming than those dependent

on others. Furthermore, irrigation agriculture needs daily follow-up and labour. Once the irrigating households left his/her farm and carried out other activities, productivity declined. Due to the above reasons, utilizing irrigation water for productivity depends on the occupation of the farming household. In some cases, if irrigating households are involved in petty trading, the households' income is maximised and fulfilling the family's needs. Therefore, it is better off than those households whose livelihood is irrigating farming alone.

Conflict over Irrigation Utilization

In the study area, conflict exists among irrigation users. The leading causes of conflict were unequal water distribution, water scheduling problems, and insufficiency problems. If mistrust exists among users, they are discouraged from utilizing the scheme and are actively involved in maintenance and cleaning.

CHAPTER V

5. CONCLUSION AND RECOMMENDATIONS

5. CONCLUSION AND RECOMMENDATIONS

The chapter summarized in this section includes the methodology and the study results. The study was carried out in one Kebele where the Irrigation scheme, situated in the Humbo District, falls under the Wolaita Zone. The random sampling procedure was used to select the 100 respondents in the Kebele Ampho Koysha. The Interview Schedule is used for quantitative data collection, and the Checklist is used for Focus Group Discussion. The primary tools completed the Key Informant Interview for qualitative data collection, and the process of collecting data was based on face-to-face interviews. The secondary data were collected from unpublished and published documents on the internet.

Data analysis involved descriptive statistics, inferential statistics and the binary logistic regression model. The main descriptive statistics employed were frequency, mean values Standard Deviation. Inferential statistics were used, such as an independent t-test for continuous variables and chi-square for the dummy variables, to measure the independent variables' association with dependent variables. Farming households' used the Binary Logistic Regression Model to test the factors affecting the utilization of the Small-scale Irrigation Scheme. The binary logistic regression model was chosen because it helps analyze data where the researcher is interested in finding the problems in utilising the irrigation scheme of a specific event.

The binary logistic regression results revealed that independent variables influence the utilization of irrigation by farming households. However, not all independent variables influence the irrigation utilization status of farming households. The dependent variable is whether farmers are irrigators or non-irrigators, and independent variables are the educational level of households, family size of households, livestock holding of households' heads, total cultivated land of household heads, frequency of contact by extension workers, Access to input supply, occupation of household heads and conflict over irrigation water utilization. A total of 16 independent variables, of which 8 have significantly affected the utilization of irrigation schemes at a different significant level (1%,5%and 10%). The 7 of them were insignificant, and the remaining 1 variable was rejected and not entered into Binary Logistic Model due to multi-co-linearity, i.e. membership in the Water Users Association. The significant variables 2 influenced at a

5% significance level, such as the educational level of household heads and household heads' occupation of household heads .4 variables such as Livestock holding of household heads. Family Size of household heads, Landholding of household heads, and Access to Input Supply by household heads influenced Irrigation Utilization of farming household heads at a 1% significance level. The remaining 2 variables, like frequency of extension contact and conflict over Irrigation Water Utilization, were negatively influenced by the Irrigation Utilization status of household heads at a 5% significance level.

5.1. Conclusion

This study assessed the irrigation utilization status of farming household heads in the study area, categorized as Irrigators ($Y=1$) and Non-irrigators ($Y=0$). 16 different independent variables were selected to conduct a study. After, their co-linearity was tested by using both contingency coefficients for the dummy and variance inflation factors for continuous variables, respectively. One variable should not be correlated with the remaining independent variables; the researcher rejected it before entering variables into binary logistic regression for analysis. The independent variables were selected under four factors: Socio-demographic, Institutional, Psychological and Economic factors by referring to secondary variables sources. The data gathered from the sample units were analyzed using descriptive and inferential statistics. The degree of influence of independent variables on dependent variables was measured by entering variables into a binary logistic regression. It revealed that the following independent variables influenced the dependent variables ($Y=1$, for Irrigators and $Y=0$, for Non-Irrigators) at three levels of statistical significance (less than 1%, 5% and 10% probability levels).

Based on the above summary explanation of variables, the significant variables are those with significant values. The significant variables include: the educational level of the farming household heads, family size of household heads, livestock holding of farming household heads, landholding of farming household heads, frequency of the extension contact to the farming household heads, access to input supply by farming household heads, occupation of the farming household heads and conflict exist among irrigating household heads.

Significant variables mean that the relationship between the Depend Variable (Irrigation Utilization) and Independent Variables is true. We can claim it as sufficient evidence to support that positive or negative relationship. The other Seven Independent variables, such as Sex of the household heads, age of the household heads, dependency ratio, perception of farmers towards utilization of irrigation scheme, access to credit, access to market information, and total income are not significant as their significant levels are greater than 0.05. They are 0.755, 0.348, 0.998, 0.999, 0.205, 0.160, and 0.387 respectively. This resulted in these variables being insignificant in the model. Based on these conclusions, the following recommendations were made for policy implementation.

5.2. Recommendations

- The district education office, in collaboration with the district office of agriculture and rural development, should strengthen Adult education with practical learning by stressing the importance of irrigation farming, the way for active participation, modern technology application, cropping methods, ways of pest control through employing teachers who took training on adult literacy by salary with necessary farm equipment and teaching-learning materials. Moreover, education and training facilitate communication between farmers and agricultural information providers like extension workers.
- The family size in the study area did not appear as one of the pressing issues. Nevertheless, it was significant for this study. Therefore, more contraceptive inputs could be given to an already ongoing family planning program to make contraceptives available for both men and women. In addition, they provided training and discussion concerning how to efficiently utilise those economically active family members as a source of labour for irrigation farming through labour division among family members. Contrary to these, households with small farming could be engaged full-time in their farms rather than looking for off-farm and non-farm activities.
- The district office of Agriculture and Rural Development has appointed Development Agents (DA) could help the farmers to make the total size of their landholding cultivated

correctly and manage it by using modern techniques of production and cropping high-value crops rather than producing crops and vegetables which have a short duration of seasons and harvest times. In addition, organizing frequent training and recruiting model farmers for visiting areas well known for horticulture farming develops practical knowledge and motivation for doing the things they already observed from the place they visited.

- The district Agriculture and Rural Development office, through their sectoral classification team, namely, Animals health and Ranching and Development Agent, who is working in the study area, could be organizing an awareness creation workshop on immediate reporting of livestock diseases at their infancy stage before the livestock are seriously affected. Moreover, in addition to the above risk condition, they are also providing frequent short-term training in preparing and planting grasses serving as forage during dry cropping seasons around irrigated farm plots, and animals breeding, Since agriculture activities in general and irrigation farming, in particular, is carryout by livestock especially, oxen and also it is one of the income sources of farming households (Irrigators and Non- irrigators).
- The Ministry of Agriculture and District Agriculture and Rural Development department should mandate that Development Agents in general and irrigation development professionals meet at least twice a week. Their attendance and topics advise farmers on the following necessary and pressing issues: irrigating techniques, crop selection, input utilization amount, soil fertility maintenance, and equal water utilization condition through scheduling, keeping irrigation canals from destruction, siltation, and weed problem. Moreover, the government and NGOs working in the district on the related project area should build the capacity of Development Agents by designing long and short-term training. In addition, the local Kebele Administrators, District Agriculture and Rural Development Expertise should make intense monitoring and evaluation of irrigation schemes necessary to provide feedback and information for the future planning, management and utilization of the scheme sustainably.
- The District Agriculture and Rural Development Office should provide inputs at the correct times of cropping seasons. The Development Agent should practically

demonstrate how to apply input on the farm and the amount needed for each crop type. For those who have input through credit, the District Agriculture and Rural Development preserve credit in crop harvesting time than in the time of cropping and also provides the amount of input proportional to landholding.

- The government and other stakeholders should establish agro-based industries to create a market for farm produce and prevent low prices due to excess production. In addition, employment and new business opportunities could benefit landless and/or low-income households. They depend on irrigation farming as their primary occupation and a sector that generates many incomes and sustainable livelihood strategies.
- Local communities prefer local routes such as associations and conflict resolution committees from formal study areas. This is because of a stronger sense of identity and belongingness than in formal setups. Therefore, attention should be given to such informal institutions to strengthen their capacity and create a strong linkage with formal institutional arrangements. Furthermore, through time the demand for irrigation water increases among beneficiary farmers. Therefore, assigning water rights and strengthening the organization and operation of WUAs will be essential for the further efficient use of the shared pool resource. Furthermore, training of the development agents and water users association officials is an essential way of addressing the communities so the government and NGOs should plan to build their capacity on the following pressing issues like creating local understandings, management style, community responsiveness, equal distribution of water, conflict resolution, input supply and source of market information delivery system.

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<https://www.youtube.com/watch?v=aFO4h8i-h6g>

7. APPENDICES

7. APPENDICES

7.1. Appendix I: Conversion Factor to estimate Tropical Livestock Unit Equivalent

Appendix Table 1: Conversion factors to estimate Tropical Livestock Unit equivalents

Animal Category	TLU	Animal Category	TLU
Calf	0.25	Donkey (young)	0.35
Weaned calf	0.34	Camel	1.25
Heifer	0.75	Sheep and Goat (adult)	0.13
Cow and ox	1.00	Sheep and Goat (young)	0.06
Horse	1.10	Chicken	0.013
Donkey (Adult)	0.70		

Source: Storck *et al.*, (1991)

7.2. Appendix II: Interview Schedule for Irrigation users and Non-user Households

SMALL-SCALE IRRIGATION UTILIZATION BY FARMERS IN SOUTHERN ETHIOPIA

General Instructions to the Respondents

These Interview schedules are prepared to undertake a study on *the Analysis of Small scale Irrigation Scheme utilization status by Farming Households*. The interview schedule aims to gather information on irrigating and non-irrigating households' socio-economic, agricultural and non-agricultural activities, access to services and other important information.

Dear respondents, this study will help different stakeholders and policymakers take appropriate measures on irrigation development in the future. Your responses are kept confidential for academic purposes only. Therefore, you are kindly requested to provide genuine responses. Thank you for your time and cooperation!

Specific Instructions to Enumerators

1. Make a greeting first.
2. Thanks! The respondent was voluntarily attending the interviews.
3. Tell the objective of the interview.
4. When you do the interview, please! Use the local language.
5. Name of numerator _____ sign _____ date _____
6. Respondent Identification Code: Irrigator _____ Non- Irrigator _____
7. Finally, thank the respondents after you finish the interview.

I. Socio-demographic factors

1. Age and sex

Age Category (Years)	SEX		TOTAL
	MALE	FEMALE	
Individuals who are under 15			
Individuals who are 15-64			
Individuals who are above 64			

2. Education of the Household:

0=Illiterate 1=Read and Write 2=Elementary completed 3=Junior Completed
4=High School completed and Above

3. Religion:

1=Orthodox 2=Chtholic 3=Protestant 4=Muslim 5=Others

4. Marital Status of the Household:

1=Married 2=Single 3=Divorced 4=Widowed

5. Total Family members of the Household _____

6. Occupation:

1=Farmer 2=Trader 3=Housewife 4=Student 5=Herding 6=Weaving
7=Blacksmith 8=Carpentary 9=Servant/maid 10=Handicraft 11=Construction
12=Others (Specify)_____

7. Dependency Ratio: 1=(0-14) 2=(15-64) 3=(64 and Above)

II. Economic Factors

Crop Production

Table 7.1. Crops, Vegetable and Fruit Production in Rainfed Agriculture from November 2012-June 2013

S. No.	Types of Crops	Plot Size	Total Production (Kg)	Consumed at home (Kg)	Sold		
1	Teff						
2	Maize						
3	Wheat						
4	Barley						
5	Sorghum						
6	Finger Millet						
7	Beans						
8	Peas						
9	Chickpeas						
Total							
Types of Vegetables/Fruits							
10	Tomato						
11	Potato						
12	Pepper						
13	Onion						
14	Cabbage						
15	Kosta						
16	Carrot						
17	Avocado						
18	Mango						
19	Orange						
20	Banana						
21	Lemon						
22	Others						

Crop Code List: 1=Teff, 2=Maize, 3=Wheat, 4=Barley, 5=Sorghum, 6=Finger Millet, 7=Beans, 8=Peas, 9=Chickpea, 10=Tomato, 11=Potato, 12=Pepper, 13=Onion, 14=Cabbage, 15=Kosta, 16=Carrot, 17=Avocado, 18=Mango, 19=Orange, 20=Banana, 21=Lemon, 22=Others

Table 7.2. Crops, Vegetables and Fruits Production in Irrigation Agriculture from November 2012-June 2013

S. No.	Types of Crops	Plot Size	Total Production (Kg)	Consumed at home (Kg)	Sold		
1	Teff						
2	Maize						
3	Wheat						
4	Barley						
5	Sorghum						
6	Finger Millet						
7	Beans						
8	Peas						
9	Chickpeas						
Total							
Types of Vegetables/Fruits							
10	Tomato						
11	Potato						
12	Pepper						
13	Onion						
14	Cabbage						
15	Kosta						
16	Carrot						
17	Avocado						
18	Mango						
19	Orange						
20	Banana						
21	Lemon						
22	Others						

Crop Code List: 1=Teff, 2=Maize, 3=Wheat, 4=Barley, 5=Sorghum, 6=Finger Millet, 7=Beans, 8=Peas, 9=Chickpea, 10=Tomato, 11=Potato, 12=Pepper, 13=Onion, 14=Cabbage, 15=Kosta, 16=Carrot, 17=Avocado, 18=Mango, 19=Orange, 20=Banana, 21=Lemon, 22=Others

8. Why do you select the above type of vegetables/Crops for your Irrigation Farming?

1=Better Price

2=Good Production

3=High disease tolerance

4=Easiest to Cultivate

Livestock Holding

9. Do you have livestock? 1=Yes 2=No

10. If Yes, indicate the number of Livestock you had last year:

Livestock Number	Types of Livestock										
	Oxen	Local Cows	Bull	Heifers	Calves	Goat	Sheep	Camel	Donkey	Bees	Hens

11. How did you operate your farming activity last year?

1=Using own oxen 2=Coupling with other farmers 3=Borrow from friend and/or

relatives 4=By contributing labor to a person who has Oxen 5=By sharing the land

6=Others (Specify) _____

12. Have you been unable to cover land under crop due to a shortage of Oxen?

1=Yes 2=No

13. If Yes, how much of land size not covered by crops _____?(Hectare)

Household Total Income

14. Did any family member get involved last year in Non/Off-farm activities?

0=No 1=Yes if the answer is Yes, in which one from the following table

S. No.	Off-Farm/Non-Farm Activities	Amount (Birr)	Remark
1	Working on other farms		
2	Daily labourer in construction or other Non-farm activities		
3	Self-employment in manufacturing, E.g. Artisan (Blacksmith, Weaving, Pottery)		
4	Sales of Wood (Charcoal)		
5	Sales of Local drinks		
6	Transportation by carts		
7	Hairdressing		
8	Sales of Stone/Sand		
9	Salary from temporary or Permanent Employment		
10	Remittances		
11	Trade		

Land Holding

15. How many plots do you have? Irrigated Plots _____ Non-Irrigated Plots _____

16. Provide the following information for each Irrigated plot during 2012-2013

S. No.	Questions	Plot 1	Plot 2	Plot 3
1	Approximate size of the plot (Kert/Timad)			
2	Crop grown			
3	Distance of plot from the house (Km)			
4	For how many years did you use Irrigation			
5	Who owns the plot 1=Household, 2=Share cropping, 3=Rented 4=Others			
6	If rented, the amount paid (Birr)			
7	Terms of Rent 1=Monthly, 2=Quarterly, 3=Yearly			
8	Have you ever faced flooding/ 1=Never, 2=Occasionally, 3=Every year			
9	How many months do you Irrigate the plot in a year?			

III. Institutional factors

Access to Agricultural Extension services

17. Do you receive any extension services available in your locality?

0 = No 1 = Yes

18. If yes, do you gain any knowledge from the extension agents that could help you do things differently on the specific commodities?

0 = No 1 = Yes If no, specify your reason _____

19. Which advice do you receive for extension workers?

1=crop husbandry 2=crop diversification 3=animal husbandry 4=marketing 5=credit

6=conservation farming 7=fruits and vegetables 8=irrigation 9=household food security

10=farm management 11=farm power 12=post harvest processing 13=storage of farm produce

20. Did you receive any advice of this type during the 2012/2013 seasons?

1=Yes 0=No

21. What was the most important source of such advice?

1. Extension officer 2. farmer group 3. Field days 4. Radio 5. Publications

6. Marketing agents 7. NGO 8. Fellow farmer 9. Other Specify-----

22. How often did you receive advice from this source?

1. Once a week 2. Once a month 3. 2 to 3 times a month

4=once in 3 months 5=once a season

23. Did you use any advice during the last agricultural season?

1=Yes 0=No

24. If No, why didn't you use the advice?

1=Irrelevant 2=Lack of funds 3=Lack of inputs 4=Others specify--

25. Would you like to receive more advice on this type? 1=Yes 0=No

Access to Agricultural Credit

26. Do you need credit for the production of your agricultural products? 0 = No 1 = Yes

27. If Yes, do you have access to credit for the production of the Commodities?

0 = No 1 = Yes

28. Is credit timely and adequately available for agricultural commodities development?

0 = No 1 = Yes

29. Have you got any type of credit (cash or kind) in 2012/13? _____ 1=Yes 2= No

30. If your answer is 'Yes' to the above question, do you take the credit?

1= Purchase of improved seeds 2= Purchase of fertilizer 3= Purchase of chemicals

4= Purchase of oxen 5= Purchase of small ruminant animals 6=others (specify)

31. What are your sources of credit?

S. No.	Types of the Credit Source	Response		Remarks
		Yes	No	
1	Agricultural service cooperatives			
2	Local Government Banks			
3	Traditional Informal Association (Idir etc.)			
4	Local institutions (Self Help Groups)			
5	Omo Micro-finance			
6	NGOs			
7	Friends and relatives			
8	Other (specify)			

32. If you did not take credit last year, why are you not interested?

1= Fear of inability to pay back 2= Lack of collateral 3= Lack of access to credit

4= High-interest rate 5= Since I have no shortage of money

6=Others (specify)_____

Agricultural Input Supply

33. Did you use improved seed varieties in past production times? 1= Yes 2=No

34. If your answer is 'Yes' for # 37, did you face a problem using improved seeds?

1= Yes 2= No

35. If you faced a problem using improved seeds, what are those problems?

36. Did you use inorganic fertilizer in past production time? 1 =Yes 2=No

37. Do you use chemicals to kill pests if you have a problem? 1= Yes 2=No

Water User Association

38. What are the main objectives of using irrigation? (Rank according to importance)

1=to generate cash income

2= to produce food for the household

3=produce livestock feed

4=Others (specify)_____

39. Do you participate in irrigation association activities?

1=Yes 0=No

40. If Yes, what are the activities?

1= _____ 2= _____

3= _____

41. Do you have an irrigation Water Users Association? 0=No 1=Yes

42. If yes, how was the association formed?

43. Who makes decisions on the sequence of using irrigation water?

1= _____

2= _____

44. Do you make any payments for using water for irrigation? 0=No 1=Yes

45. If yes, how much do you pay? (Birr)_____

46. How do you pay?

1=per month 2=per year 3= per plot 4= other (specify)_____

Access to Market

47. Do you supply your product to the market? 1=Yes 2= No

48. What are your market areas and their distance from your residence?

Name/place of market	Is it your preferable market place		Distance from the marketplace to your home (Km)
	Yes	No	
Humbo			
Gulgula			
Sodo			

49. In what ways do you sell your farm products?

1. Taking to the local market individually 2. Through service or producer cooperatives 3. Others (Specify) _____

50. Do you have a transportation problem? 1=Yes 2= No

51. How far is the distance from your home to the main road? _____ Km

52. What means of transport do you use to transport your product to the market?

- 1= Human power 2= Trucks 3= Animal power 4=Others (specify) _____

53. Do you have a market information centre in your local area?

- 1=Yes 2=No

54. Where did you get the information while you sold your products?

Sources of Market Information	Response		How often Per week You got the service
Agricultural/Service Cooperative			
Irrigation producer associations			
Government Cooperatives and marketing.			
NGOs			
Others			

IV. Psychological Factors

Conflict

55. Do you get enough water for irrigation during all periods?

- 1= Yes 2= No

56. Which group of irrigation users getting more water?

- 1= Head end 2= Middle end 3= Tail-end

57. How far is your irrigated plot from the source of irrigation water? _____ in meter

58. How far is your irrigated land from your residence/home? _____ in walking hours

59. Have you ever faced any conflict with neighbouring farmers using irrigation?

- 0=No 1=Yes others _____

60. If Yes, what were the problems or sources of the conflict? Rank

1= water theft

2= misuse of water

3= non-user animal drink

4= unequal maintenance contribution

61. If yes, what measures were taken to resolve the conflict?

1= through community Elders

2= through court

3=local discussion

62. What was the penalty passed for the user found guilty?

1=in cash

2=in kind

3= others, specify _____

63. What is your contribution to the management of the irrigation scheme?

1) Labor contribution in cleaning and maintaining the structure 2) Money contribution

3) Other (specify) _____

64. In your understanding, what are the major challenges of not effectively utilising the constructed modern irrigation scheme? (Rank them)

S. No.	Major Problems	Ranks
1	Poor irrigation method practice	
2	Weed problem	
3	The distance from irrigable land to the farmer's home is very far to properly manage their farming	
4	Pest and disease occurrence	
5	Poor canal management and cleaning	
6	Poor crop selection/pattern	
7	Lack of efficient extension support	
8	Lack of provision of improved seeds	
9	High-cost purchasing of agricultural inputs	
10	Transportation problem	
11	Marketing problem	
12	Free grazing	

Perception

S. No.	Statements	Strongly agree	Agree	Undefined	Disagree	Strongly disagree
1	Irrigation can ensure food security					
2	In the utilization of the scheme, there was a lack of improved seeds					
3	Good agricultural extension support exists					
4	Credit providing institution is available but not accessible					
5	No problem in the utilization of water among users					
6	High-cost purchasing of agricultural inputs					
7	Market access for the production					
8	Poor crop selection					
9	Credit availability for Agriculture					
10	No need for food Aid for irrigation users					

7.3. Appendix III: Checklists for Focus Group Discussion (FGD)

1. What are the significant farming activities practised by smallholders in the area?
2. How do you see the constructed irrigation scheme's function in providing enough food for the target community?
3. What are the primary determinants for producing enough food at the household level?
4. What is the influence of access to irrigation on crop production and employment opportunities for a rural household in the area?

5. What are the sources of irrigation water? Is irrigation water available throughout the year?
6. What are the role and members of the irrigation scheme water user association?
7. What are the rules and regulations (bylaws) practised by Water User Association?
8. What are the significant constraints or drawbacks of using irrigation water in order of importance?
9. 9 What is the nature of conflict related to irrigation water and what measures are taken to resolve conflicts?
10. How is water distribution handled for all beneficiaries? Who is more favoured, and who is not? Why?

7.4. Appendix IV: Checklists for Key Informant Interview (KII)

1. What is/is the socio-economic contribution of small-scale irrigation for the Woreda?
2. Is there any social conflict in Woreda due to the expansion of small-scale irrigation?
3. What is the impact of small-scale irrigation on the natural resource base of Woreda?
4. How does the organization resolve water disputes among users within Woreda?
5. What are the organization's rules and regulations in irrigation water allocations if there is water scarcity?
6. What are the supports provided by the Woreda irrigation office to small-scale holders in the area?
7. What looks like your organization's level of communication with the different water users in the area? (Investors, state farms, farmers, pastoralists, and other institutions)
8. Do you think the organization is efficient enough to manage the irrigation system in the woreda? If not, why?
9. What are your organisation's main problems in managing a small-scale irrigation system?
10. What do you suggest to improve small-scale irrigation in Woreda?

7.5. Appendix V: Checklist for Woreda Water office officials

1. Could you describe your institution's role in the Ella site's existing irrigation scheme management system?
2. How do you see the importance of the irrigation scheme to economic well-being and, in particular, growing crops needed to improve the food supply?
3. What are the constraints observed in the utilization of irrigation water and the possible solution needed to upgrade the scheme's potential, such as changes in irrigation method, delivery and storage systems, adjustments in crops and irrigated acreages, or improved scheduling in the delivery system? How do you see the current condition of the scheme canals and structures and their maintenance work?
4. Is the water available throughout the season, and how is it determined to distribute to irrigation users?
5. Are there any existing Water User Associations? Are they effective in distributing water equitably and efficiently? Can they maintain the irrigation systems and collect fees for canal maintenance? What can be done to improve existing organizations?
6. How do you see the cooperation between all users involved in improving the operation, maintenance, and irrigation system?
7. What are the water laws of the region and the community bylaws established to secure a fair utilization system among users?
8. What marketing support is given to smallholders, like the availability of price and marketing information and tackling the marketing bottlenecks and problems in transportation?

8. ETHIOPIA – KEY TECHNICAL TERMS

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These are the Key technical terms that are typically used by Ethiopians practically. These Key technical terms will be helpful to other nationalities to know about the actual meaning of the significant words for the users who are reading this E-Book. The words from agro-ecological categories of land, agro-climatic seasons of the year, Informal Institutions, public Administrative Units like districts and villages etc. The Ethiopian researchers have also generally used these concepts in their Thesis research documents. That is why; we have prepared a list of key terms that will make you understand this document.

Belg: Long Rainy Season starts from February to June every year

Birr: Ethiopian Currency

Dega: Highland altitude

Development Agent: The one disseminating the new technology and innovations to the model farmer and fellow Village farmers. There are many Development Agents for Agriculture, Health, Livestock and Natural Resource Management for every Kebele in Ethiopia.

Idir/Edir: The social customary Informal Financial Institutions in the Village help people in an emergency like a death ceremony, or a natural catastrophe like drought, or flood.

Iqub/Equb: It is a traditional Informal economic Institution existing in both the Urban and the Village that serves to save cash. Equb will help poor people who cannot buy clothing, food, household equipment, etc. The small group consists of 30 to 40 members of the society who used to contribute 2 to 5 Birr weekly, and each member collects a maximum of 300 Birr. It is one of the popular mutual support schemes often formed by people affiliated with one another.

In other words, the number of members depends on the availability of like-minded people in the locality. Besides, the amount of money each member can contribute also depends on the wealthiness of all members. Collection time can also be determined based on mutual agreements weekly, every 15 days or monthly.

Indigenous Social Insurance Systems: Idir/Edir, Mahber, Iqub/Equb

Kebele: A type of administrative division at the lower level, higher than the village. Kebele means “Village” in the Ethiopian language. The Kebele is the basic administrative unit of the Ethiopia Government.

Kert: Small plot size of land equivalent to 0.05 hectares

Kolla: Lowland mainly lower than 500 m above sea level.

Mahber: It refers to a support union, which is usually formed based on religious, ethnic, professional etc., affiliation whereby members contribute some amount of money voluntarily, which they will later use for individual, group, or community support programs.

Meher: Short Rainy Season starts from July to September every year

Time Difference: Ethiopia Standard Time is 3 hours ahead of Greenwich Mean Time (GMT+3). Ethiopia is in East Africa Time Zone (EAT).

Timid: Size of a plot of land covered by one pair of Oxen equivalent to 0.25 hectares.

Woreda: is called “District”. Local administrative above Kebele level, which is equivalent to a District.

Woynne Dega – Mid Highland altitude

Year Difference: An Ethiopian year comprises 13 months, seven years behind the Gregorian calendar. Ethiopians celebrated the new Millennium on September 11, 2007; the Ethiopians continued with the same calendar that the Roman church amended in 525 AD. Ethiopia's current year is 2012, and Europe a year is 2020.

9. GLOSSARY

9. GLOSSARY

Adaptive Research: Research conducted to validate, modify and/or calibrate a new technology to specific soil, climate, socioeconomic or environmental characteristics of a given area.

After-Cultivation: Harrowing, rolling, tilling, and other cultivations carried out in a field after the crop has emerged

Agrarian system: The pattern of land distribution, ownership, management, and the agrarian economy's social and institutional structure.

Agribusiness: Agriculturally related businesses that supply inputs (such as fertilizer or equipment) or are involved in the marketing of farm products, such as warehouses, processors, wholesalers, transporters and retailers. This is the combination of the producing operations of a farm, the manufacture and distribution of farm equipment and supplies and the processing, storage and distribution of farm commodities.

Agriculture area: Land used primarily for producing or collecting farm commodities. According to the land uses, a distinction is made between arable land, land under protective cover, land under permanent crops in the open air, and land under permanent meadows and pastures, both naturally grown or cultivated.

Agriculture holding: Economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production, without regard to title, legal form or size.

Agricultural Operation: The management and use of farming resources to produce crops, livestock or poultry.

Agricultural Production: Measured in the total output of a crop.

Agriculture: A broad class of resource uses includes all forms of land use to produce biological (biotic) products – whether animal or plant. The fundamental basis for agriculture is the miraculous process of photosynthesis, the many valuable products synthesized by it, and plants and animals, including human beings. Nature has endowed soils with immense

nutrients, which support much of the agricultural activity. Agriculture is now predominantly dependent on external nutrient support to supplement soil fertility.

Agro-climatic Regions: The grouping of different physical areas into broadly homogenous zones based on climatic and edaphic factors.

Agro-ecological Zone: A land resource mapping unit, defined in terms of climate, landform, soils, and land cover, and having a specific range of potentials and constraints for land use. Essential elements in defining an agroecological zone are the growing period, the temperature regime and the soil units. A significant area of land is broadly homogenous in climatic and edaphic factors but not necessarily contiguous, where a specific crop exhibits roughly the same biological expression. Zones of similar agricultural performance are defined by soil and climate.

Altitude: Vertical distance above sea level.

Analysis of Variance: Analysis of variance is a method for testing a hypothesis about means. It is the most widely used statistical inference method for analysing experimental data.

Annual Crops: Crop plants complete their life cycles within a season or year, such as rice, wheat, maize, coffee and plantains. They produce a crop of seeds and die. Some of these crop plants may produce tillers. If such rooted tillers are separated from the main shoot and planted, each tiller will survive that season as a new plant but will not live until another disease.

Arable Land: Land is ploughed, and crops are cultivated: agriculture is based on field crops such as Sorghum, millet, maize and vegetables. Arable land includes all land used in most years for growing temporary crops and lying fallow or has not been sown due to unforeseen circumstances. Arable land does not include land under permanent crops or land under protective cover.

Asset ownership: Land ownership, physical capital (factories, buildings, machinery, etc.), human capital, and financial resources generate income for owners.

Attitudes: The states of mind or feelings of an individual, group, or society regarding issues such as material gain, hard work, saving for the future, and sharing wealth.

Basic education: The attainment of literacy, arithmetic competence, and elementary vocational skills.

Bedload (erosion): The sediment moves by sliding, rolling or salting on or near the streambed sediment, mainly by tractive or gravitational forces, but at velocities less than the surrounding flow.

Bed: Narrow flat-topped ridge on which crops are grown with a furrow on each side to facilitate irrigation and drainage of excess water or an area in which seedlings or sprouts are grown before transplanting.

Biodiversity: The variety of life forms within an ecosystem.

Biodegradable: A substance which can be broken down or decomposed. As a result of biochemical changes typically involving bacteria or fungi, e.g. cellulose is degradable cellulose decomposing fungi. This property reduces composting time by inoculating the material to be composted with suitable microbes.

Broadcasting: The action of spreading seeds, fertilizer or other agrochemicals on the soil surface. It is usually done before planting and commonly incorporated with tillage but may be unincorporated in no-till systems.

Bund: A low embankment, wider than a ridge, usually higher than 20cm but lower than 1m, used to control runoff on irrigated land. Bunds are characterized by the materials used (earth bund, stone bund or mixed bund), their shape (triangular bund, trapezoidal bund, semi-circular bund), their dimension (large semi-circular bund) and their position across the slope (contour bund), graded water diversion bund, straight water diversion bund, and presence of ties if any (tie bund).

Case Study: The detailed study of an individual unit such as a household, farm, enterprise or activity. It contrasts with the survey approach in which several units are studied. The case-study approach is helpful for familiarisation and teaching purposes, whereas the

survey approach is more oriented toward gaining information about the population of the relevant unit.

Check Dam: Small dam builds across a gully or other small watercourse at suitable points to control water levels and regulate downstream discharges.

Check Row Planting: The planting process in which row-to-row and plant-to-plant distances are uniform, and plants across the rows are also in line.

Check Basin Irrigation: Check-basin irrigation method is the most common method among surface irrigation methods. The field is divided into small plots surrounded by small bunds on all four sides in this method. Water from the head channel is supplied to the field channels one after the other. Each field channel supplies water to two rows of check basins, and water is applied when the field is quite large and it is not easy to level the entire field. In such situations, the field is divided into small strips and each strip is into several plots by putting bunds, and these plots are called check basins. The advantage of this method is that the water can be applied uniformly and effectively. Therefore, it is suitable for close-growing crops like groundnut, wheat, millet etc. The disadvantages are that more labour is required, and more land is wasted under channels and bunds. In addition, inter-cultivation is not possible due to bunds.

Central Tendency: There are many measures of the centre of a distribution. These are called measures of Central Tendency. The most common are the mean, median and mode.

Class Interval: The class interval is a data division used in a histogram. For instance, it is possible to partition scores on a 100 point into class intervals of 1-25, 26-49, 50-74 and 75-100.

Confidence Interval: A confidence interval is a range of scores likely to contain the parameters being estimated. Intervals can be more likely to contain the parameters: 95% of 95% confidence intervals contain the estimated parameter, whereas 99% of 99% confidence intervals contain the estimated parameter. The wider the confidence interval, the more uncertainty there is about the parameter's value.

Constant: A value that does not change values such as T_i or the mass of the Earth is constant

Continuous Variables: Variables can take on any value in a specific range. Time and distance are continuous; gender SAT score and “time rounded to the nearest second” are not. Variables that are not continuous are known as discrete variables. No measured variable is truly continuous; however, discrete variables measured with enough precision can often be considered continuous for practical purposes.

Commercial Farming: Specialized farming enterprise that is capital-intensive and aimed at profit maximization.

Community Forestry: Forestry developed in areas marginal to agriculture, with many community members being landless or small-scale farmers, often characterized by ecological and cultural diversity and the employment of traditional technologies. Communal land development is fundamental to this type of forestry.

Conservation of Natural Resources: The main principles of protecting natural resources are related to the improvement and use of natural resources that will assure their highest economic or social benefits for humans and their environment now and into the future. The management of human use of the biosphere may yield the most significant sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment.

Conservation Practice: Any technique or measure used to protect the soil and water resources for which standards and specifications for installation, operation or maintenance have been developed.

Conservation Tillage: Any tillage and planting system leaves at least 30% of the soil surface covered by residue after planting. Conservation tillage maintains a ground cover with less soil disturbance than traditional cultivation, reducing soil loss and energy use while maintaining crop yields and quality. Conservation tillage techniques include minimum

tillage, mulch tillage, ridge tillage and no-till. Conservation tillage varies widely with crop and soil type.

Conservation: The management of natural resources to provide maximum benefits over a sustained period. In farming, conservation entails matching cropping patterns and agricultural lands' productive potential and physical limitations to ensure profitable production's long-term sustainability. Conservation practices focus on conserving soil, water, energy and biological resources. Contour farming, no-till farming, and integrated pest management are standard conservation practices, divided into land management practices and structural practices.

Contiguous Drought: Drought resulting from irregular precipitation patterns cause a moisture deficit during the rainy season.

Contour: Linear demarcations of the land surface indicate places of equal elevation; the lines on a map connect these points.

Contour Bunding: This practice consists of making a comparatively narrow-based embankment at intervals across the land's slope on a level along the contour. It is an important measure that conserves soil and water in arid and semi-arid areas with high infiltration and permeability. It is commonly adopted on agricultural land up to a slope of about 6 per cent. These cross-sections of the bunds can be used as a guide in similar situations. It may be noted here that as no specifications for bunding in deep black soil are available so far, no large-scale bunding on them can be recommended, pending further research.

Contour cropping: Sowing a crop in rows or strips so that these follow along a contour.

Contour Crops: These crop plants are grown on or along the contour lines to protect the land from erosion, for instance, marvel grass, Dinanath grass, Setaria and Anjan grass.

Contour Farming: Field operations such as ploughing, planting, cultivating and harvesting on the contour or right angles to the natural slope reduce soil erosion, protect soil fertility and use water more efficiently.

Contour Flooding: Method of irrigation by flooding from contour ditches.

Contour Furrow: A furrow ploughed on pasture or rangeland to prevent soil loss to allow water to penetrate the soil, sometimes used in planting trees and shrubs on the contour.

Contour Tillage: The cultivation of land along the lines of uniform elevation or contour lines reduces erosion.

Crop Productivity: This is the quantitative production of a crop in terms of its primary production per unit of land area. It is usually expressed as kg or tonnes per hectare. Same as crop yield. Example. Eight Tonnes grain/ha.

Crop residue management system: The operation and management of cropland to maintain stubble, stalks, and other crop residues on the surface to prevent wind and water erosion, conserve water, and decrease evaporation.

Crop Residues: These represent the bulk of the crop biomass left after removing the primary produce (grain, fruit, etc.) from the field. Most crops produce a voluminous amount of residues, e.g., straw, stalk, stubble, trash, husk, etc., which can be used for mulching, ploughing back, compost making, and industrial raw material fuel, thatch or fed to animals. It is often discarded or burnt, which must be avoided to conserve and recycle organic matter and nutrients. Crop residues contain a substantial proportion of plant nutrients. Their N content and C mainly control their N: C ratio mineralisation. The critical N content of organic materials for net mineralization is between 1.70 and 1.80% N. Rice straw contains 0.58, 0.23 and 1.66% N, P₂ O₅ and K₂ O, respectively.

Crop Yield: The data reported under this element represent the harvested production per unit of harvested area for crop products. In most cases, yield data are not recorded but obtained by dividing the data stored under the production element by those recorded under the element; area harvested. Data are recorded in Kilograms or tons per hectare.

Cropping Pattern: The yearly sequence and spatial arrangement of the crops or crops and fallow in a given area. Includes sequential or multiple cropping, intercropping, mixed cropping, relay cropping etc. Example: rice followed by wheat, maize followed by wheat followed by the green gram.

Cultivable Area: Area of land potentially fit for cultivation. This term may or may not include part or all of the forests and rangeland.

Cultivar: A variety of plant species produced by selected breeding.

Cultivation: A tillage operation used in preparing land for seeding or transplanting or later for weed control and loosening the soil. The growing field crops, vegetables, fruits, trees, flowers, and fish.

Cut-off time (irrigation): In surface irrigation, the time at which the supply of water is cut off at the top end, leaving the water already supplied to flow down the slope.

Cutback irrigation: Water is applied in-furrow irrigation faster at the beginning of the irrigation period and then reduced or cut back to a lesser rate, usually one-half the initial rate or that amount to balance with the intake rate.

Cut-off drain: A drainage system for draining seepy hillsides. Tiles are placed along the hillside to intercept the seepage water and prevent it from reaching the bottomland, or an open channel is dug along the hillside to achieve the same effect.

Deforestation: Those practices or processes that result in the change of forested lands to non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1. The burning or decomposition of the wood releases carbon dioxide; 2. Trees that once removed carbon dioxide from the atmosphere in photosynthesis are no longer present and contribute to carbon storage.

Degradation: The process whereby a compound is transformed into simpler compounds. The changing of soil to a more highly leached and highly weathered condition; is usually accompanied by morphological changes such as the development of an A2 horizon.

Demonstration: Practically showing the user the working of a particular practice or technology developed and established on a research farm.

Drought: An insufficient moisture supply from precipitation or soil for optimum plant growth. A period of abnormally dry weather was sufficiently prolonged for the lack of water to cause a severe hydrologic imbalance (i.e. crop damage) in the affected area. Drought severity

depends upon the degree of moisture deficiency and the affected area's duration and size. It is months or years when a region notes a deficiency in its water supply. Generally, a region receives below-average precipitation over an extended period. It is usually ranging from several months to several years. Although droughts can cause significant damage, drought is a regular, recurrent feature of the climate for most regions. Having adequate drought mitigation strategies in place can significantly reduce the impact. In the worst-case scenario, recurring drought can also bring about desertification. As a drought persists, its conditions worsen, and its impact on the local population gradually increases.

Dry Farming: The practice of crop production in low-rainfall areas without irrigation. Crop production without supplementary irrigation in semi-arid regions is dependent on precipitation. Dryland farming requires the capture and efficient use of precipitation. Therefore, farming activities should be focused on retaining precipitation, reducing evaporation and utilizing drought-tolerant crops. Rainfed farming includes dryland farming, though these terms are not interchangeable. Both systems exclude irrigation, but rainfed agriculture can emphasize, i.e. the safe disposal of excess water.

Deforestation: The clearing of forested land for agricultural purposes or logging and use as firewood.

Dependent Variable: A variable that is explained or affected by another variable. It is a variable that measures the experimental outcome. In most experiments, the effects of the independent variable on the dependent variables are observed.

Developing Countries: Asia, Africa, the Middle East, Latin America, Eastern Europe, and the former Soviet Union are presently characterized by low living and other developmental deficits. Used in the development literature as a synonym for less developed countries.

Development: The process of improving the quality of all human lives and capabilities by raising people's levels of living, self-esteem, and freedom.

Diversified (mixed) farming: The production of staple and cash crops and simple animal husbandry is typical of the first stage in the transition from subsistence to specialized farming.

Discrete Variable: Variables that can only take on a definite number of values are called “discrete variables”. All qualitative variables are discrete.

Dummy Variable: An artificial variable

Earth Dam: An embankment dam in which more than 50 Percent of the total volume is formed of compacted fine-grained material obtained from a borrow area (i.e. excavation area). Earth dams retain water in a small valley or depression where water flows regularly.

Ecological Resilience: Ecological resilience can be defined in two ways. The first is measuring the magnitude of disturbance that can be absorbed before the ecosystem changes its structure by changing the variables and processes that control behaviour. The second, a more traditional meaning, is a measure of resistance to disturbance and the speed of return to the equilibrium state of an ecosystem.

Economically Sustainable: The characteristic of prolonged, careful, efficient and prudent (wise and judicious) resources (natural, fiscal, human), products, facilities and services. It is based on thorough knowledge and involves operating with little waste and accounting for all costs and benefits, including those not marketable and can result in savings.

Environment: The combined external condition affecting an organism's life, development and survival or ecosystem.

Environmental capital: The portion of a country's overall capital assets directly related to the environment - for example, forests, soil quality, and groundwater.

Environmental System: A system where life interacts with the various abiotic components in the atmosphere, hydrosphere and lithosphere.

Environmentally Sound: The maintenance of a healthy environment and the protection of life-sustaining ecological processes. It is based on thorough knowledge and requires or will result in products, manufacturing processes, developments, etc., which are in harmony with essential ecological processes and human health.

Factors of production: Resources or inputs required to produce a good or a service, such as land, labour, and capital. The inputs used in a production process. Generally,

terms can be classified as land, labour, capital and management. However, in functional production analysis, management is not usually included as it cannot be readily measured, and land, labour and capital may be further divided into different types.

Family farm: A farm plot owned and operated by a single household.

Farm Enterprise: An individual crop or animal production function within a farming system is the smallest unit for which resource use and cost return analysis is customarily carried out.

Farm Forestry is growing trees for timber, poles and fuelwood on farmland. This may be done in Small woodlots or as boundary plantings.

Farmer: The principal decision-maker involved in the management of a farm. Usually, but not always, will be head of the household. Sometimes the choice of principal decision-maker will be somewhat arbitrary since the decision-making may sometimes be segregated for different farm activities.

Farming System: Unit of analysis of agricultural production, defined by the components and boundaries and the types of interactions among the components and environments outside the boundaries. Farming systems include all agricultural and non-agricultural, under the control of farm household units. A decision-making unit comprising a farm household, cropping, livestock, and fish production systems produces a crop and animal products for consumption and sale.

Farm System Analysis: Investigations of farm-level constraints, translation of this knowledge into improved technologies, and testing of this technology.

Farming Systems Types: Shifting cultivation, fallow systems, ley and dairy systems, systems with permanent upland cultivation, systems with arable irrigation farming, perennial crops and grazing systems etc.

Fixed Assets: Durable assets represent long-term investments for more than one production cycle. Examples are breeding livestock, plant and machinery, land and building etc.

Flora: Denotes plant population of a particular area, as fauna is for animal production.

Food Insecurity: A situation exists when people lack secure access to sufficient amounts of safe and nutritious food for average growth and development and active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal or transitory.

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

Forest Grazing: Any situation (silvopastoral) where timber-producing trees and grazed pasture are grown together as an integrated management system, the prime objective being to increase long-term net profit per hectare. It is growing pasture under trees as an alternative source of income to thinning timber or pulpwood.

Forest Plantation: Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They have introduced species (all planted stands) or intensively managed indigenous species.

Fauna: The animal life in a specific place or soil at a particular time. Microscopic members are called micro-fauna. Examples: nematodes.

Focus Group Discussion: A Qualitative method of data collection in which the information is collected in the context of a group through relevant discussion

Forestland: Land on which the vegetation is dominated by forest or, if trees are lacking, the land bears evidence of former forest and has not been converted to other vegetation.

Forestry: The science of establishing, cultivating, and managing forests and their attendant resources. The science, art and practice of managing and using for human benefit the natural resources that occur on and in association with forest lands.

Fragile land: Land sensitive to degradation when disturbed, such as with highly erodible soils, soils where salts can and do accumulate, and soils at high elevations.

Furrow Irrigation: A method similar to corrugation irrigation used in permeable soils. It consists of feeding narrow furrows very close to one another with small discharges to quickly wet all the soil between two rows of crops (often orchards). Furrows parallel to the rows may be laid mechanically and reduce erosion.

Furrow: A trench or extended narrow cut in the soil after a plough passes through it, a trench or ditch dug by hand. An opening left in the soil after a plough or disc has opened a shallow channel at the soil surface. A shallow channel cut in the soil surface, usually between planted rows, controls surface water and soil loss or conveys irrigation water.

Gender roles: Learned behaviours that condition activities, tasks, and responsibilities viewed within a given society as “masculine” or “feminine”.

Global Warming: Certain gases such as carbon dioxide, methane, nitrous oxides and Chloro Fluoro Carbons (CFCs) absorb infrared radiation and trap it within the earth's atmosphere. This heat, which would typically be dissipated into space, increases the earth's temperature. An increase in the earth's temperature would profoundly affect the world's sea levels and climate. The control of these gases is, therefore, seen as a major international priority.

Greenhouse effect: The greenhouse effect causes the atmosphere to trap heat energy at the Earth's surface and within the atmosphere by absorbing and re-emitting longwave energy. Of the longwave energy emitted back to space, 90% is intercepted and absorbed by greenhouse gases. Without the greenhouse effect, the Earth's average global temperature would be – 18°Celsius, rather than the present 15°Celsius. In the last few centuries, human activities have directly or indirectly caused the concentration of the major greenhouse gases to increase. Scientists predict that this increase may enhance the greenhouse effect making the planet warmer. Some experts estimate that the Earth's average global temperature has increased by 0.3 to 0.6° Celsius, since the beginning of this century, because of this enhancement.

Gross Domestic Product: The statistical measure of the total economic value of all the goods and services an economy produces in a given year. The size and rate of GDP growth are often taken as indicators of the level of development achieved by a society. However, GDP also contains many items such as spending to clean up environmental damage, treat drug addicts, keep criminals in jail etc., that reflect social difficulties rather than social wellbeing. Moreover, GDP excludes essential items such as the unpaid costs of environmental damage and the lost value of depleted natural resources.

Groundwater run-off: Water from a catchment area that moves freely under the influence of gravity and enters the soil.

Groundwater: Water in the soil beneath the surface, usually under conditions where the pressure in the water is greater than the atmospheric pressure, and the soil voids are substantially filled with the water. That portion of the water is below the ground's surface, more significant than atmospheric pressure.

Growing Season: It is used generally, not as a technical term, to refer to the period of the year when most crops are grown, e.g. the rainy season. The year period is when the environment enables farmers to produce a crop of economic value.

Gully Erosion: A channel resulting from erosion caused by the concentrated but intermittent water flow, usually during and immediately following heavy rains. Deep enough (usually >0.5 m) to interfere with and not be obliterated by normal tillage operations.

Green revolution: The boost in grain production associated with the scientific discovery of new hybrid seed varieties of wheat, rice, and corn has resulted in high farm yields in many developing countries.

Habitat: The place or type of site where species and communities typically live or grow is usually characterized by a relatively uniform portion of the physical features or consistent plant form. Deserts, Lakes and forests are all habitats.

Heterogeneous: Non-uniform, variable, coming from outside. Their heterogeneous nature causes their outside. Their heterogeneous nature causes their constituents to segregate. Example: physical fertilizer mixtures.

Hidden Hunger: The nutritional status of a growing plant when it is experiencing a nutrient deficiency, but this effect is not severe enough to produce visible deficiency symptoms. One stage is below the critical level. However, hidden hunger does result in a loss in crop yield. A sound nutrient management programme aims at preventing hidden hunger.

Household: A household in the Ethiopian case is understood similarly as FAO (2005:4) defines “a household is an economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes, without regard to title, legal form or size”. Households represent rural societies' primary production and consumption unit and are agents of economic change. ii. Composed of the farmer and his family. It is considered both the production and consumption unit of the social organization. The household can be managed by one person or operation collectively. Family members live, sleep, eat, share the same place, and divide household duties, general farm management, and work.

Human capital: Productive investments embodied in human persons, including skills, abilities, ideals, health, and locations, often resulting from expenditures on education, on-the-job training programs, and medical care.

Independent Variable: A variable that does not need to be explained by or is not affected by another variable. The variable is manipulated by the experimenter, as opposed to dependent variables. Most experiments observe the effect of the independent variable(s) on the dependent variable.

Indicator: A directly observable trait used to define a variable empirically.

Inferential Statistics: The type of statistics that makes conclusions from data derived through sampling and projects them onto the population

Informal sector: The part of the urban economy of developing countries characterized by small competitive individual or family firms, petty retail trade and services, labour-intensive methods, free entry, and market-determined factor and product prices.

Infrastructure: Facilities enable economic activity and markets, such as transportation, communication and distribution networks, utilities, water, sewer, and energy supply systems.

Integrated Drainage: It is a general term for a drainage pattern in which stream systems have developed to where all parts of the landscape drain into some part of a stream system. The initial or original surfaces have disappeared the region drains to an ordinary base level.

Integrated Farming System: The Integration of various agricultural enterprises, viz., cropping, animal husbandry, fishery, forestry etc. A judicious mix of any one or more with cropping complements the cropping enterprise.

Intellectual Property Rights: A right enabling an investor to exclude imitators from the market for a limited time.

Intensive Cropping Systems: Such cropping systems make relatively continuous use of the land for crop production. These do not allow a fallow period, and two or more seasonal crops can be raised in a year on the same piece of land through sequence cropping, inter/mixed cropping or both. Example: rice-wheat system, maize-wheat-green gram system, coconut-pineapple-black pepper multi-storeyed cropping systems in which 4 crops grow in a field at any given time.

Intensive Cropping: Maximum land use utilizing the frequent succession of harvested crops.

Intensive Farming: A farming system produces the maximum number of crops in a year with a high yield from the land available and maintains a high livestock stocking rate.

Intercropping: The growing of two or more crops on the same field per year, simultaneously or in the case of relay intercropping with an overlapping period. Simultaneously systems refer to the cultivation of two or more crops intermingled or with distinct row or strip arrangements. Here there is one main crop while the others are subsidiary crops, for instance, sesame+groundnut+sorghum+wheat+rice+mustard. It refers to growing two or more generally different crops simultaneously on the same land, base crop necessarily in a distinct row arrangement. The recommended optimum plant population on the base crop is suitably combined with an appropriate additional plant density of the associated crop. There is crop intensification in both time and space dimensions.

Inventory is a list of assets and liabilities, which are claims or debts against the business; in other words, it is a detailed list of farm properties with the value assigned.

Irrigable Area: Area capable of being irrigated, principally regarding the availability of water, suitable soils, and land's topography.

Irrigated Land: The areas artificially provided with water, other than rain, improve pastures or crop production. Uncontrolled land flooding by overflowing river streams is not considered irrigation.

Irrigation Canal: A permanent irrigation canal constructed to convey water from the source of supply to one or more farms.

Irrigation Methods: How water is controlled and applied to an area. One of four irrigation methods used to apply irrigation water; is surface sprinkle: Micro and sub-irrigation. One or more irrigation systems can be used to apply water to each irrigation method.

Irrigation Schemes: Areas of irrigation schemes where water is wholly or partially controlled. These schemes may be under individual or collective control. They are classified as significant (often public schemes), medium and small schemes.

Irrigation System: Physical components (pumps, pipelines, valves, nozzles, ditches, gates, siphon tubes, turnout structures) and management used to apply irrigation water by an irrigation method. All properly designed and managed irrigation systems have the potential to apply water across a field uniformly.

Irrigation Water Management: Managing irrigation applications based on the soil's water-holding capacity and the crop's need. The water is applied at a rate and in such a manner that the crop can use it efficiently, and resource losses are minimized. Irrigation efficiency is the ratio of water stored in the crop root zone compared to the amount of water applied.

Irrigation Water Requirement: The calculated amount of water needed to replace soil water used by the crop (soil water deficit) for leaching undesirable elements through and below the plant root zone, plus other needs, after consideration, is made for adequate precipitation.

Irrigation: Water is artificially applied to soil and confined in time and space, usually for crop production. It enables it to meet the water requirements at a given time of its vegetative cycle or bring the soil to the desired moisture level outside the vegetative cycle. The irrigation of a field includes one or more watering per season. Water distribution systems for irrigation at the field level may be broadly classified into the systems of the flowing kind, which cause more or less uniform wetting of all the soil in the field. Irrigation does not include precipitation. A distinction is made between surface irrigation (basin, border, furrow irrigation) and localized irrigation (an umbrella term for other irrigation systems such as trickle, drip, drip, daily flow and micro and overhead irrigation (sprinkler irrigation)).

Integrated Rural Development: The broad spectrum of rural development activities, including small-farmer agricultural progress, the provision of physical and social infrastructure, the development of rural nonfarm industries, and the capacity of the rural sector to sustain and accelerate the pace of these improvements over time.

Key Informants: These are community members who are exceptionally qualified to provide information about local conditions, usually due to their position within the community, e.g. local officials, community leaders, and other development workers. Key informants may provide background information or introductions to other community members or groups. The qualitative information will help to triangulate with quantitative data of the research.

Land Area: Total area excluding area under inland water bodies.

Land Capability: The suitability of land for use without permanent damage. Land capability, as ordinarily used in the USA, is an expression of the effect of physical land conditions, including climate, on the total suitability for use without damage to crops that require regular tillage, grazing, woodland, and wildlife. The land capability involves considering the risks of land damage from erosion and other causes and the difficulties in land use owing to physical land characteristics, including climate.

Land Cover is the observed (bio) physical cover on the earth's surface. When considering land cover, describe the vegetation and the manufactured features. Consequently, areas

where the surface consists of bare rock or bare soil describe land itself rather than land cover. Also, water surfaces can be disputed as being natural land cover. However, in practice, the scientific community describes those aspects under the term land cover. Land cover is not to be confused with land use. For example, woodland or forests are land covers, but the land use may be hunting or rubber tapping.

Land Degradation: Deterioration is in land quality. Due to natural processes or human activity, such land can no longer sustain an economic function properly and/or the original natural ecological function.

Land Leveling: Land preparation involves moving soil from high to low spots to achieve a flat horizontal surface so that irrigation water will be evenly distributed throughout the field.

Land Preparation: The process of preparing the soil is for planting to provide a soil environment favourable for plant germination and/or growth.

Land Quality: A complex land attribute that affects its suitability is distinctly for specific uses. For example, the land quality “availability of water” directly affects crop yields and land suitability for different crops. Most land qualities can only be assessed by modelling the interaction of several land characteristics. For example, water availability is modelled from data on rainfall, the available water capacity of the soil, and potential evapotranspiration.

Land System: A land unit has a relatively uniform climate and a repeating pattern of landforms, soils, and vegetation. A land system may be divided into land facets.

Land Tenure: Land tenure refers to arrangements or rights under which the holder holds or uses land. Land rented out is not considered to be part of the holding. A holding may be operated under one or more tenure forms, with each parcel normally operated under one tenure form. All data regarding land tenure should be collected for the same time reference. Many land tenure systems allow people to use the same property for different purposes. For example, farming rights can belong to one person, while the trees to another and the fruit of the trees to someone else. Leasing and renting are kinds of land tenure, just as is share-cropping.

Land forming: Tillage operations move soil to create desired soil configuration. Forming may be done on a large scale, such as gully filling or terracing, or a small scale, such as contouring, ridging, or bedding.

Landholdings: Land owned, occupied, or used by farmers or tenant farmers.

Landscape: The fundamental traits of a specific geographic area, including its biological composition, the physical environment and anthropogenic or social patterns. A collection of related landforms; is usually the land surface the eye can comprehend in a single view. The landscape is a distinct association of landforms, as operated on by geological processes (exo-or endogenic) that can be seen in a single view.

Landslide: Term used to describe the downslope movement of soil, rock and other weathered materials because of gravity. A general term for a mass movement landform and a process characterized by moderately rapid (greater than 30 cm per year) downslope transport, through gravitational stresses, of a mass of rock and regolith may or may not be water-saturated.

Land-use: Land-use is characterized by the arrangements and activities inputs people undertake in a particular land cover type to produce, change, or directly link land cover and people's actions in their environment. A crop is not land use. The recreation area is a land use term for different land cover types: sandy surfaces like a beach, a built-up area like a luna park, a forest etc.

Land reform: A deliberate attempt to reorganize and transform agricultural systems to foster an equal distribution of agricultural incomes and facilitate rural development.

Least Developed Countries: A United Nations designation of countries with low income, low human capital, and high economic vulnerability.

Likert Scale: The respondent has to choose a scale introduced by Likert employing a set of response categories ranging from positive to very negative.

Linear Regression: A method of estimating the value of a Dependent Variable when the values of two-interval scaled and normally distributed variables are known.

Literacy: The ability to read and write.

Livelihood Diversification: In this study, livelihood diversification refers to the attempts by households to construct diverse ways to raise incomes and reduce vulnerability to different livelihood shocks. Therefore, livelihoods diversification is defined comprehensively as the proportion of both on-farm and non/off-farm activities in households' income-generating portfolios. Livelihood diversification can occur through agricultural diversification, i.e., production of multiple crops or high-value crops and livestock, and non-agricultural livelihood diversification, i.e., undertaking small enterprises or choosing nonagricultural sources of livelihood like casual labour or migration.

Livestock Systems: A subset of farming systems, including cases in which livestock contribute more than 10 per cent to total farm output in value terms or where intermediate contributions such as animal traction or manure represent more than 10 per cent of the total value of purchased inputs.

Livestock Unit: A standard live weight unit for all grazing animals based on their respective live weight. A standard LU is 500Kg, with adult cattle representing 1.0 LU and adult sheep representing 0.0 LU.

Livestock: Refers to all animals kept or reared, mainly for agricultural purposes. It includes aquaculture for fish production.

Low-income countries (LICs): In the World Bank classification, countries with a gross national income per capita of less than \$976 in 2008.

Microfinance: Financial services, including credit, supplied in small allotments to people who might otherwise have no access to them or have access only on very unfavourable terms, including micro-savings and micro-insurance and microcredit.

Multiple Regression: Multiple regression is linear regression in which two or more predictor variables are used to predict the criterion

Non-farm Income: The typical non-farm activities that are pursued by rural households in Ethiopia: non-farm rural salaried employment; non-farm rural self-employment (sometimes

called micro-enterprise income); rental income obtained from leasing land or property; urban to rural remittances arising from within national boundaries; other urban transfers to rural households, for example, pension payments and international remittances arising from cross-border migration.

Non-Governmental Organizations (NGOs): Nonprofit organizations often provide financial and technical assistance in developing countries.

Off-farm income involves working on other farms for wages or arrangements such as sharecropping or labour exchange in-kind. Off-farm income is strictly defined as income generated from working outside one's farm through participating in ploughing, weeding or harvesting on another farmer's land. Moreover, we also consider income from local environmental resource extraction such as firewood collection, charcoal production and gathering of wild fruits as off-farm income.

On-farm Income: Income generated from farming, whether on owner-occupied or leased land, includes livestock and crop income. Income is derived from crop production and the rearing and selling of animals. This includes income earned from commercial woodlots and beekeeping.

Pilot Study: A complete replica of the leading research study is employed in a fraction of the sample.

Positive Association: There is a Positive association between X and Y if smaller values of X are associated with smaller values of Y and larger values of X are associated with larger Y values.

Pre-test: A small-scale test administered before introducing a study aimed at measuring the efficacy of one or more main study elements. It helps to modify and update the Interview Schedule/Questionnaire.

Qualitative Data: The data to be collected should be from Community leaders, priests, and elderly people who are highly experienced in the research area.

Quantitative Data: The data to be collected from the concerned respondents or any published reports quantitatively.

Qualitative Variable: Also known as Categorical Variables, qualitative variables with no natural sense of order. They are, therefore, measured on a nominal scale.

Random Sampling: The process of selecting a population subset for statistical inference. Random sampling means that every member of the population is equally likely to be chosen.

Regression: Regression means “prediction”, the regression of Y on X, the prediction of Y by X.

Regression Analysis: A method employed to study the relationship between variables, especially the extent to which a dependent variable functions one or more independent variables.

Sample: A group of units chosen to be included in a study

Significance: A criterion related to the validity of data.

Significance Level: In significance testing, the significance level is the highest value of a probability value for which the null hypothesis is rejected. Expected significance levels are 0.05 and 0.01. If the 0.05 level is used, the null hypothesis is rejected if the probability value is less than or equal to 0.05.

Smallholder Farmer: In Ethiopia, the smallholder farmer meets the conventional meaning of small farms of less than 2 hectares per household. They are known for their resource constraints like capital, inputs and technology; their heavy dependence on household labour; their subsistence orientation; and their exposure to risks such as reduced yields, crop failure and low prices

SPSS: A statistical package for Social Sciences that the software could support with the help of computer-assisted research data analysis.

Social capital: The productive value of social institutions and norms, including group trust, expected cooperative behaviours with predictable punishments for deviations, and a shared history of successful collective action, raise expectations for participation in future cooperative behaviour.

Social system: The organizational and institutional structure of a society, including its values, attitudes, power structure, and traditions.

Soil Degradation: A process that describes human-induced phenomena that lower the soil's current or future capacity to support human life. Improper use by humans commonly causes a decline in soil quality. This includes physical, chemical and/or biological deterioration. Its consequences are loss of organic matter, a decline in soil fertility, a decline in structural condition, enhancement in erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants or excessive flooding.

Soil Fertility: The overall ability of a soil to support vigorous crop growth by ensuring adequate plant nutrients and suitable conditions for water uptake and providing favourable conditions for root growth and development. Fertility synthesises chemical, physical and biological components and is influenced by climatic and management factors. Its assessment helps decide whether fertilizer application rates which is the primary function of soil fertility, are low and inadequate to support the desired level of plant production. Fertilizer application aims to increase soil fertility.

Soil Management: The total of all tillage operations; cropping practices; decisions; usage of inputs including fertilizers, amendments, bio-fertilizers, pesticides, herbicides; and other treatments such as irrigation and drainage conducted on or applied to soil for plant production and soil conservation.

Soil Productivity: The capacity of the soil, in its typical environment, to produce a specified plant or sequence of plants under a specified management system. It emphasizes the capacity of the soil to produce crops and is expressed in terms of yield.

Soil erosion: Loss of valuable top soils resulting from overuse of farmland, deforestation, and consequent flooding of farmland.

Staple food: The leading food consumed by a large portion of a country's population.

Stakeholders: A large group of individuals and groups of individuals (including governmental and non-governmental institutions, traditional communities, universities, research institutions, development agencies and banks, donors etc.) with an interest or

claim (whether stated or implied) which has the potential of having an impact on a given project and its objectives. Stakeholders with a direct or indirect “stake” can be at the household, community, local, regional, national or international levels.

Stream: (watercourse, river) Body of water, generally flowing in a natural surface channel. Water flowing in an open or closed conduit, a jet of water is issuing from an orifice or a body of flowing groundwater.

Stream-bank erosion: Torrents are defined as hill streams characterized by wide-spreading beds on emergence from the hills with ill-defined banks, flashy flows and swift currents. Usually, they are dry watercourses, except during the rainy season. With every downpour in their catchment, they get very swollen with flood and subside almost to their average tiny size immediately after the storm is over. These sudden and violent flows are responsible for moving immense quantities of detritus, comprising boulders, shingles, sand and silt, depending upon the terrain's geology. This debris gets deposited in the torrent bed in the form of scattered islands due to the sudden widening of the torrent channel after it emerged from the hills or the gradient's flattening in the lower reaches, or obstructions caused by wild vegetation and uprooted trees. These deposits raise the bed level of the torrent. These deposits, in turn, reduce the transporting capacity of the torrent, resulting in the transporting capacity of the torrent resulting in overflow, the meandering of the course, and the banks' erosion.

Subsistence Crop: The crop grown under problematic conditions when no other crop can be grown, such as floating rice in flood-prone areas.

Subsistence farm: A low-income farm emphasising production for the farmer's use or the farmer's family rather than for sale.

Subsistence Farming: Growing crops and, where appropriate, keeping animals to provide food (cereals, pulses, vegetables and fruits), shelter materials, and possibly other products (fibres, medicinals) for family use.

Sub-surface Irrigation: Irrigation of crops by applying water below the surface of the ground through pipes.

Surface Irrigation: It is a method of irrigation when the water is applied to the land by allowing it to flow by simple gravity before infiltration. It includes various systems depending upon the relative magnitude of the surface flooding and infiltration phases after accumulation (submersion).

Surface runoff: Water from a catchment area is discharged or lost without entering the soil.

Surface Soil: The uppermost part of the soil, ordinarily moved in tillage, is equivalent to uncultivated soils ranging in depth from 7 to 25 cm. Therefore, it is frequently designated as the surface layer plough layer.

Surface tillage: Cultivating or mixing the soil to a shallow depth.

Surface water: All waters on the earth's surface, including fresh and saltwater, ice and snow, as distinguished from subterranean water, oceans, lakes, rivers etc. The runoff is from paved or unpaved land or buildings, distinct from sewage.

Sustainability: Managing soil and crop cultural practices to degrade or impair environmental quality on or off-site without eventually reducing yield potential due to the chosen practice through exhaustion of either on-site or non-renewable inputs.

Sustainable Agriculture and Rural Development (SARD): The management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable.

Sustainable Agriculture: An integrated system of farming that will, over the long term, satisfy food and fibre needs, enhance environmental quality, make the most efficient use of resources, sustain the economic viability of farm operations and enhance the quality of life. Overall, sustainable agriculture emphasizes management practices that take advantage of natural processes (such as nutrient cycles, nitrogen fixation, and pest-predator

relationships), improve the match between cropping patterns and agronomic practices on the one hand and the productive potential and physical characteristics of the land on the other. Commercial fertilizers and pesticides are used selectively to ensure production efficiency and conservation of soil, water, energy, and biological resources. Sustainable agricultural practices include crop conservation tillage systems, including no-till planting methods, integrated pest management, and genetically improved crops and animals.

Sustainable Development: The management and conservation of the natural base, and the orientation of technological and institutional change, in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. It conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically feasible and socially acceptable.

Sustainable land use: Land use that achieves production sufficient to meet the needs of present and future populations while conserving or enhancing the land resources on which that production depends.

Sustainable Production Systems: Production systems are designed to remain viable indefinitely by not degrading the resource base, impeding continued production indefinitely. Sustainable implies continuous improvement based on the concept that we continue to learn about the results of our interaction with complex ecosystems. Therefore, we must remain in a constant mode of learning and documentation to hone our systems toward a perfect form.

Sustainable Use: The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations. The uses of the biological products and ecological services of ecosystems are in a manner and at a rate that does not reduce the system's ability to provide those products and services to future generations. Sustainable use of the environment and its living resources is used at a rate that does not exceed its capacity for renewal to ensure its availability for future generations. Sustainable management involves our current generation while conserving natural resources and protecting the environment for the benefit of future generations.

Sustainable: Production systems that can meet present needs without reducing the capability to meet future needs. FAO has defined sustainability as “Sustainable development is the management and conservation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable”.

Temperature: The measure of molecular motion or the degree of heat of a substance. It is measured on an arbitrary scale from absolute zero, where the molecules theoretically stop moving. It is also the degree of hotness or coldness. Surface observations refer primarily to the free air or ambient temperature close to the earth's surface.

Terrace: A step-like surface bordering a stream or shoreline representing the former position of a flood plain, lake or seashore. A raised, generally horizontal strip of earth and/or rock constructed along a hill on or nearby on a contour to make the land suitable for tillage and prevent accelerated erosion. An earth embankment is constructed across a slope for conducting water from above at a regulated flow to prevent accelerated erosion and conserve water.

Tillage: The mechanical manipulation of the soil profile for any purpose, but in agriculture, it is usually restricted to modifying soil conditions and/or managing crop residues and/or incorporating chemicals for crop production.

Tiller: A vegetative branch of the rice plant composed of roots, culm, and leaves may or may not develop a panicle. Shoot arising from the main culm (stem).

Topsoil: The upper part of the soil, with the lower limit set at 30cm or shallower. The soil depth may be limited by a root growth-inhibiting layer, a hard rock, a pedo-genetically indurate layer, a chemically unfavourable layer, or a strongly contrasting layer.

Topography: The relief exhibited by a surface. It refers to the differences in elevation of the land surface on a broad scale. It is derived from the site's most representative or characteristic slope gradient.

Underdevelopment: An economic situation characterized by persistent low levels of living in conjunction with absolute poverty, low income per capita, low rates of economic growth, low consumption levels, poor health services, high death rates, high birth rates, dependence on foreign economies, and limited freedom to choose among activities that satisfy human wants.

Watershed: (catchment, catchment area, drainage area, drainage basin, river basin): A physiographic unit in the landscape defined by the drainage dividers around the area drained by a particular body of water. If a lake, there is often one watershed with subunits for contributing streams. If a river, it may be defined for any point or all. The whole surface drainage area contributes to water or a lake. The total area above a given point on a stream contributes water to the flow at that point (syn: 'drainage basin', 'river basin'). Regardless of size, the total area above a given point on a waterway contributes runoff water to the flow at the point. A major drain-area subdivision of a drainage basin is based on this concept.

Watershed Analysis: A systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. The watershed analysis is a stratum of ecosystem management planning applied to watersheds.

Watershed Degradation: A marked deterioration in the hydrological behaviour of a river system, which reduces the potential of land and water by causing a water flow of inferior quality, quantity and timing.

Watershed Management: Planned use of watersheds (river basins) following predetermined objectives.

Wealth Ranking: Information on households' relative wealth (or well-being) in a community can be gathered. Community members define how wealth (or well-being) is perceived locally and then put the households into those with the most significant level of wealth to the least. This technique is best used with individuals, but it should be carried out with at least three community members to avoid inherent biases arising due to the status of the respondents.

World Bank: An organization known as an “international financial institution” that provides development funds to developing countries in interest-bearing loans, grants, and technical assistance.

Yield: The aggregate of products from growth or cultivation, usually expressed in quantity per area. Amount of production per unit area over a given time. A measure of agricultural production. Crop yield can be total dry matter yield (grain+straw) or economic yield (grain only). They are usually expressed as Kg/ha, Mg/ha (Mg=Megagrams) or tonnes/ha. The expression “quintals (100/Kg) /ha” is getting out of use.

10. SUBJECT INDEX

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Prof. Dr. Seda Yıldırım

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Achieving sustainable water sources is vital to keeping food and water security long-term. As the 2030 Sustainable Development Goals determined, food and water sources are related. Accordingly, water usage in the agriculture sector should be planned carefully. Significantly, the African region should develop new projects or programs to achieve water efficiency and sustainable farming activities. This book gives new evidence explaining how farmers utilize small-scale irrigation schemes in Southern Ethiopia. The study gives a sample case from Qabala in the Humbo District, where the Irrigation scheme falls below the Wolaita District. So, it will contribute to policymakers and future studies to launch new water usage programs for farming in the developing or the least developed countries such as Ethiopia.



Prof. Dr. Samantha Curle

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Agriculture is the backbone of the Ethiopian economy, supporting the country's secondary and tertiary sectors development. Moreover, agriculture is a primary sector that ensures self-reliance in national-level food availability. It also can enhance growth in the other sectors of the economy through increased commercialization and dynamic inter-sectoral linkage effects. However, the fast-growing population poses a problem to agriculture to increase the agricultural production and productivity per hectare of land. The low productivity of agriculture, coupled with other problems, has led to its poor performance of agriculture. Despite their noticeable achievements, efforts of Ethiopian farmers and development practitioners have failed to address the ground reality problems like irrigation water and different types of agricultural inputs requirements, etc., to the village farmers. This book is an outgrowth of the author's long and rich experience in water-saving technologies and conducting original research in the field.



Prof. Dr. Predrag Ilic

Director and Scientific Advisor of Institute for Protection and Ecology, Banja Luka, Republic of Srpska, Bosnia

The government, development partners and communities have made many technical efforts to improve the food security situation of smallholders by creating access to irrigated agriculture. The perennial Hamasa River, found in the eastern part of Humbo District, was targeted to serve one accessible Kebele, named Ampho Koisha, in the Woliata Zone of SNNPR in 1985. Likewise, a preliminary assessment made by District Agriculture Office in 2012 observed that the irrigation water utilization status had not shown any progress, which has a tremendous effect on agricultural production and the food security situation of the area. Since irrigation is one of the intervention strategies to maximize productivity and ensure the food security condition of the smallholder farmers in the study area, the status of utilization of the scheme by the farming households was not currently better. This book is an outgrowth of the author's long and rich experience in water-saving technologies and conducting original research in the field.



Prof. Dr. Mohamed Rabie

President, Arab Thought Council in Washington

In most of Ethiopia, production from rain-fed agriculture is highly fluctuating, corresponding to the amount and distribution of rainfall. Because of little rainfall or uneven distribution pattern, crop failure has become the norm rather than the exception. Therefore, Irrigation Agriculture must be considered a priority in transforming agriculture and guaranteeing food security, a strategy that the Ethiopian government needs to articulate and adopt. Increased water availability and less dependency on rain-fed Agriculture should increase food production and assure self-sufficiency in Ethiopia, despite its rapidly increasing population. This book is an outgrowth of the author's long and rich experience in water-saving technologies and original research in the field.

