THE PRACTICE OF RAINWATER HARVESTING IN ETHIOPIA: PERCEPTION AND PROGRAM IMPLEMENTATION IN KALU WOREDA, SOUTH WOLLO ZONE, AMHARA REGIONAL STATE

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

REGIONAL AND LOCAL DEVELOPMENT STUDIES

BY

AMARE YIRDAW

JUNE, 2006

ADDIS ABABA

THE PRACTICE OF RAINWATER HARVESTING IN ETHIOPIA: PERCEPTION AND PROGRAM IMPLEMENTATION IN KALU WOREDA, SOUTH WOLLO ZONE, AMHARA REGIONAL STATE

A THESES SUBMITTED TO SCHOOL OF GRADUATE STUDIES, ADDIS ABABA UNIVERSITY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN REGIONAL AND LOCAL DEVLOPMENT STUDIES.

BY
AMARE YIRDAW

JUNE,2006
ADDIS ABABA

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE PRACTICE OF RAINWATER HARVESTING IN ETHIOPIA: PERCEPTION AND PROGRAM IMPLEMENTATION IN KALU WOREDA, SOUTH WOLLO ZONE, AMHARA REGIONAL STATE

BY

AMARE YIRDAW

APPROVED BY BOARD OF EXAMINERS

______________________	______________
Chairman	Signature
Woldeamlak Bewket	[signature]
Advisor	Signature
Gezahegn Ayele	[signature]
Internal Examiner	Signature
Daniel Kassahun	[signature]
External Examiner	Signature

This thesis has been submitted for examination with my approval as university advisor.

Name: Woldeamlak Bewket, Ph.D

Signature: ______________________

Date of Submission: ______________

Acknowledgements

Above all Glory is to God for his gifts beyond expression of words. The completion of this paper and my study in graduate program is not only due to my endeavor. A good number of people have contributed material and moral support for the accomplishment of this research work. First and foremost, my heart felt and special gratitude goes to Woldeamlak Bewket (Ph.D), my thesis advisor, for his constructive comments, suggestions and encouragement he rendered me in the course of writing this thesis. I found him quite cooperative and understanding.

Special thanks go to my wife w/ro. Zenebech Zewdeu, who has not only sacrificed a lot of her time and energy to manage our children but also contributed much to the success of my study through her continuous encouragement and moral support. I also owe special debt to my children Begiziew, Zelealem, Anteneh, Bizuneh, who particularly made the manuscript of the research draft ready for typing; Eskedar and Maereg for continuous moral support and inspiration they all have rendered me.

I would like also to express my gratitude to the House of Peoples' Representatives of FDRE for sponsoring my graduate studies. A profound debt has to be acknowledged to my closest friend Gurbiaw Bogale for providing me internet information and his bedroom when I am working on this research paper, Ato Atikilt Assefa for providing me reference materials, Ato Dejene Ayele for printing service and my brothers Fisha Bogale and Mebratu Bogale.

I have special obligation to extend my sincere thanks to Ato Aragaw Yimer, Ato Asmamaw Legas, Ato Abdiwasa Abdilahe who have devoted their precious time in editing the thesis, Kebede Yimam, Mekete Nega , Messfin Legesse, Kalu Woreda DAs who have rendered me pertinent data of the study Woreda and devoted their time for interview, Atsede Tsegaye, Roman Fereja and Abeba Nega who had taken the burden of typing and re-typing all parts of the research paper.

TABLE OF CONTENT Page

TABLE OF CONTENT Page

List of Tables Page

List of Figures Page

List of Appendices Page

Acronyms

ASAL	Arid and Semi Arid lands
BC	Before Christ
CARE	Cooperative for Assistance and Relief Everywhere
CRDA	Christian Relief and Development Association
DAs	Development Agents
DPPC	Disasters Prevention and Preparedness Commission
ECA	Economic Commission for Africa
FGS	Employment Generation Scheme
FAO	Food and Agriculture Organization
GHA	Greater Horn of Africa
GHARP	Grater Horn of Africa Rainwater Partnership
HHs	Household Heads
HTML	Hyper Text Mark-up Language
HTTP	Hyper Text Transfer Protocol
IFAD	International fund for Agricultural Development
ILRI	International Livestock Research Institute
IWMI	International Water Management Institute
LEISA	Low External Input Sustainable Agriculture
MoA	Ministry of Agriculture
MoARD	Ministry of Agariculture and Rural Development
MoWRD	Ministery of Water and Resource Development
MCWH	Micro Catchments Water Harvesting
OCHA	Office for the Cooperation of Humanitarian Affairs
RELMA	Regional Land Management Unit
RFWH	Runoff Farming Water Harvesting
RWH	Rainwater Harvesting
SARDEP	Semi Arid Rural Development Program
SASE	Semi Arid Savannah Environment
SIWI	Stockholm International Water Institute
SPSS	Statistical Package for Scientific Studies

Abstract

The major purpose of this study was to asses the practice of RWH scheme with particular emphasis on its challenges, strengths and potentials to enhance food security of peasant households in Kalu Woreda, South Wello Zone, Amhara Regional State. To materialize this objective, the extent of implementation, the processes, challenges and perceived potentials of the scheme have been examined in four randomly selected sample Kebeles of the study Woreda. The attitude and perception of users and non users towards the RWH scheme has also been considered.

Data for this study were gathered by means of questionnaires, interviews, FGDs and document analysis. Besides, observation to RWH structures was made. A total of 80 HHs and 20 DAs and concerned district officials were included in this study. Sample HHs were then chosen using stratified random sampling technique. Descriptive statistics had been employed to analyze the data.

The study found out that in 2004/05, about 80 percent of the plan has been accomplished. However, the distribution of constructed RWH structures indicated that about 70 percent of the structures in the study Worda were found in four sample Kebeles while the remaining 30 percent were sparsely distributed in 31 Peasant Associations. Poor quality materials used in the construction of RWH have led to the prevalence of cracks on the structures. Coupled with this is the problem of safety, which caused serious threat to children and animals. These weaknesses were identified as the major challenges that strictly hinder the potential usefulness of the program. Besides, continuous pressure from the Regional Government upon the Woreda Administration to implement its quota has led to coerce the community to involve in the RWH program at the initial phase. As such, in the survey, 58 percent of the non-beneficiaries replied as they did not lost any better agricultural opportunities being out of the RWH program and most respondents didn't also have any interest to participate in RWH scheme in the future.

Based on the above major findings, the study recommended, among other things, that a thorough analysis and selection should be made to adapt the most appropriate RWH structure to specific contexts. In addition, it is important to design an appropriate RWH plan that coincides with the implementation capacity of the Woreda Government and the Kebele Administrations instead of quota system. Before extending the RWH technology to many areas of the locality, It is also advisable to begin with a pilot project to raise the awareness level of the community and enhance the potentials of RWH program for improved food security. This is important to learn lessons from the shortcomings of the previous program.

Key words: rainwater harvesting, rainwater harvesting structure, Kalu Woreda.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Background of the study

Water is the most crucial element in sustaining the lives of people. Thus, water resource management is unavoidable theme across the globe. A number of premises establish the interdependence between water and development. Among such premises that has been often cited in literature is the link between water and poverty. First, it is argued that inadequate access to water and poor sanitation is both a cause and consequence of poverty. Water is important ingredient of food and essential for survival of life, and the lack of water contributes to the spread of disease, starvation and death. Water can also influence who is poor and who is wealthy, who has power and who loses out (UN, 2003). Second, inadequate water resource can constrain the improvement of agricultural development and food security (ECA, 1997). Water access for irrigation using affordable small-scale individualized technologies can make a dramatic contribution to household food security (IWMI, 2003).

In terms of food production, Sub-Saharan Africa has been categorized as experiencing a profound crisis. Famine and hunger are commonly widespread and frequently occurring than they used to in earlier decades. A food exporter in the 1960's, in this region has been reduced into a net food importer from the mid 1970's onwards (McLoughlin, 1970). Furthermore, it has been observed that SSA are facing environmental deterioration, widespread poverty, malnutrition and famine on a massive scale. Therefore, the situation of Sub- Saharan Africa has deteriorated to the point where it cannot feed its population (McLoughlin, 1 970; A sante, 1 986; Lemachand, 1986; T imberlake, 1 986; W orld B ank, 1992; and Hyden, 1995). Quite often, natural vagaries of weather, such as drought, are responsible for this scenario. Recent experience points to the fact that drought is by far the most critical determinant of food scarcities in the region in the recent past.

Similarly, drought is a recurrent phenomenon in most parts of Ethiopia. Drought induced hunger and starvation results severe devastation of lives. Feeding the growing population, providing better opportunities in minimizing the impacts of poverty, and achieving food security and economic growth has been still now presents formidable challenges in Ethiopia (Sally, et.al., 2003).). As Dagnew (1994) stated drought can seriously affect agricultural output and led Ethiopia to be dependent on commercial imports of food and food aids (CARE, 1998)

Although food insecurity is being experienced in all parts of the country, it is however most intensely felt in regions that are subject to inadequate rainfall, commonly described as the drought-prone areas of Ethiopia (Tasaw and Eberlei, 2004). The Amhara region is one of the drought prone areas in the country. According to the Amhara National Regional Survey conducted in 2003, the number of population in the region that was chronically affected by food insecurity was estimated to be 2,455,242, which accounted for about 17 percent of the total population of the region and 36 percent of the total population living in the food insecure Woredas of the region.

A notable reason for such situation is the dependence of farmers only on rain fed agriculture. The overall dependency on rain fed agriculture is difficult because the fluctuation in the period of rain fall can adversely affects the farming system. Consequently, this fact can also result recurrent drought and famine that brings a great deal of human suffrage and migration and considerable losses in human and livestock lives as occurred in 1974-75 and 1984-85. More often, during the 'normal' years, the food production falls below subsistence needs.

Therefore, unless sustainable food production technologies are adopted, alleviation of poverty and food security will remain elusive. One of the promising technologies for rural land use systems is facilitating rainwater-harvesting program in a conducive and sustainable manner (IWMI, 2003). Rainwater harvesting is a method, which has been used since ancient times, and is increasingly being accepted as a practical method of collecting and utilizing rainwater for domestic and agricultural purposes throughout the world.

With regard to the development and utilization of water resource in Ethiopia, it is asserted that water harvesting is not a new phenomenon for the Ethiopian farmers and pastoralists. The history of water harvesting dates back to the pre-Aksumite period, starting from 560 B.C, (Getachew, 1999). Since then rainwater was harvested and stored in ponds for agricultural and domestic water supply. However, unlike its history, water is one of the most abundant and least-developed resources of Ethiopia. Thus, the development of water resources of Ethiopia is an essential prerequisite for the development of agricultural and industrial economic sectors.

However, scholars often put a caution that the viability of this solution needs to be synchronized with environmentally sustainable factors, local climate, soils, farming systems and socio- cultural and gender perspectives in which it is practiced (UN-OCHA, 2003). It is also argued that even though RWH practices can be efficient in increasing the soil moisture for crops in water scarce areas, each technique has a limited scope due to hydrological and socio-economic limitations. Thus, RWH scheme should consider the contextual issues to improve food security in a sustainable manner.

1.2. Statement of the Problem

Drought is a central constraint for the agricultural farmers and pastoralists of the world's dry lands, and characterized by low and erratic rainfall. In those drought-prone areas, it is hardly possible to sustain rain-fed agriculture (Barton, et al., 2000). This is due to the fact that dependence only on rain fed agriculture is difficult because in some years, the rain comes early while late in others, but commonly ends too early.

In Ethiopia, food insecurity is seen as the most important challenging factor of development. Every year, more than four million people, mainly in the rural areas, have challenges of getting enough sources of food for them, and hence, they require food assistance. A combination of factors triggers the problem of food insecurity. Adverse climatic conditions such as droughts combined with high population pressure, environmental degradation, technological and industrial factors led to decline in land holding size, soil erosion and decline in productivity of yield per hectare (Tassew and Eberlei, 2004).

Amhara Region is one of the most food insecure areas of the FDRE. Particularly, Wollo was one of the hardest hit parts of the Region by the 1984/85 famine. Some of the most distressing images of the 1984/85 Ethiopian famine were seen in town of Korem, where large numbers of peasants and pastoralists gathered to seek relief in the final stages of the crisis (Allen and Thomas, 1992).

South Wollo consists of eighteen Woredas with a total of approximately 3 million people. As in most other drought-affected areas, food security in South Wello is precarious due to high population density, small landholdings, heavy reliance on often-erratic rainfall and decreasing soil fertility. Therefore, South Wollo is structurally food deficit with large number of the population heavily dependent on food aid (Veen, 2002).

Given such inextricable factors facing Ethiopia, water development and management has been given a priority for improving household's food security and agricultural transformation. In fact in the past 20 years and so decades large scale irrigation management and small river diversions had been the center of attention for both policy makers, researchers and practitioners. However, the results gained so far had little to alleviate the problem of food insecurity particularly at these drought prone areas at HHs level. Recent studies pointed out the poor practices of irrigation management at best relegate so far efforts to improve livelihood and at worst, expose people and the environment to risks (ILRI, 2002)

Since the last four years, the Federal Government of Ethiopia turned its attention to introduce new rural development policies and strategies, in which, rainwater harvesting is taken as one of the core policy strategies for combating the problem of food insecurity. The MoARD has given RWH package a due emphasis and allocated huge amount of resources. Besides, the Amhara Region has also spelled out RWH package as a panacea for its long standing problem of food security.

Following the implementation of RWH program, though they are not exhaustive, several studies have been conducted. Some of these studies, for instance the works of UN-OCHA, (2003); Ngigi, et.al (2003) have dealt with the impacts of this acclaimed strategy on alleviating the problem of food insecurity at certain specific localities of the country.

Although the aforementioned works has contributed a lot for the success of the program in line with the specific context of different localities, at least one important issue seems missing. That is, how local communities perceive and react to the process of implementing RWH and to what extent do RWH program is executed at the grassroots level. This is perhaps the most important issue because it is often said and heard that undesirable outcomes of current Ethiopian development policies lie on their implementation. Besides, it is a well established fact that what so ever any development policy strategy or intervention has been opted by policy makers for the success it has yielded to development, it is fatal to assume the benefits that accrue from such attempts unless these strategies are backed by the end-users.

Thus, the study tries to examine the perception and practice of implementing rainwater harvesting program with particular emphasis on its challenges, strengths and potentials to enhance food security of peasant households in Kalu Woreda, South Wello Zone, Amhara Regional State.

1.3. Objectives of the Study

The general objective of the study is to assess the perception of the community and overall process of RWH scheme implementation with respect to challenges, problems and potentials for improving the food security of peasant households in Kalu Woreda, South Wollo Zone. The specific objectives of the study are:

1. To describe the processes of implementation of rainwater harvestation program in Kalu Woreda.

2. To identify the major challenges and problems of rainwater harvesting practices at Kalu Woreda,

3. To assess the perceived strengths and potentials of RWH for improving HHs' food security

1.4. Research Questions

The major theme of this study, which is identified above is thought to be analyzed in line with basic questions listed hereunder:

1. How well and to what extent has rainwater harvesting scheme been implemented in the Kalu Woreda?

2. Do users perceive strong points and potentials to RWH for improving their own food security?

3. What major problems and potentials do users and non-users perceive in the process of implementation of RWH scheme?

1.5. Significance of the Study

This study deals with some procedural and attitudinal aspects in the implementation of RWH. The potentials and problems of the rain water-harvesting program in line with specific realities of various localities are not satisfactorily studied. Thus, the study is hoped to help identify contextual information on implementation issues of the program, which can serve as an initial source of knowledge and as a stepping-stone for further investigation on the subject under consideration in a wider scale.

1.6. Methodology and Research Design

1.6.1 Methodology

The study has been carried out on the case of Kalu Wereda in South Wello Zone. The use of a case study method for the study has been found useful to investigate the problem deeply and examine it with respect to the physical and socio-economic contexts of the study area.

1. 6. 2 Sampling Design

A stratified random sampling technique has been employed for the study. Among the 35 Kebele Administrations of Kalu Woreda, 4 Kebeles were randomly selected. Stratification was used to select sample sizes from both the beneficiaries and non-beneficiaries of rainwater-harvesting program. A total of 80 respondents (40 beneficiaries and 40 non-beneficiaries) were then randomly selected from four Kebeles as the subjects of the study. In addition, all the 20 development agents and concerned officials were included for the study.

1.6.3 Instruments

Both primary and secondary sources of data were taken in to account to carry out the research. The secondary data were collected from publications; documents of government institutions such as the Regional Agricultural and Rural Development Bureau and Zonal Office of Agricultural and Rural Development. Moreover, pertinent and up-dated literature has been reviewed.

The primary data were collected from peasant households, development agents and other bodies. Thus multiple data gathering instruments were employed. Questionnaires, structured interviews and observations were, however, the main ones. Informal discussions with individual farmers in the area and focus group discussions were also held. Two sets of questionnaires were used to collect data from the beneficiaries and non-beneficiaries of rainwater harvesting program. House hold survey questionnaires are preferred because they are useful instruments to collect sufficient information from a relatively large number of respondents. The questionnaire mainly contained close-ended questions, which are followed by some open-end items to give some free space for the respondents to include their idea. In addition, structured interviews were made with development agents and officials on issues that require extra clarification. To generate the necessary information with questionnaire survey, four enumerators were recruited. The enumerators were n trained how to handle their jobs. Two FGDs, one for beneficiaries and the other for non beneficiaries, were organized in each kebele.

1.6.4 Data Analysis

The analysis of data involves simple statistics that describe the study area and sample HHs. Besides, the statistical tools utilized in this study to analyze quantitative data collected through questionnaires were percentages. The quantifiable portion of the data was computed by statistical test. The qualitative portion of the data was patterned in a manner that logically supports the quantifiable data. It has been also discussed and analyzed at several points to fill the gaps and to further clarify the attitude and perceptions of sample households

1.7. Organization of the Study

The thesis has six chapters. The first chapter deals with the background of the study, statement of the problem, objective of the study, research questions, significance of the study, the methodology and research design. The second chapter presents review of related literature and the third chapter discusses the general description of the study area. The demographic and production characteristics of the study area have been treated within the fourth chapter. The fifth chapter presents the implementation and utilization of RWH scheme in Kalu Wereda and the final chapter discusses the summary of major findings and recommendations of the study.

CHAPTER TWO

2.0. REVIEW OF RELATED LITERATURE

2.1. Rainwater harvesting

Water harvesting is usually employed as an umbrella term describing the whole range of methods of collecting and concentrating various sources of runoff such as roof top runoff, overland flow, stream flow, etc for agricultural, livestock, domestic and other purposes (Reij, et al., 1988).

Rainwater harvesting is broadly defined as the collection and concentration of runoff for productive purposes crop, fodder, pasture or tree production, livestock and domestic water supply, etc (Evanari et al., 1971; Shanan and Tadmor, 1976; Critchley, 1987; Critchley and Siegert, 1991 and Agarwal and Narain, 1997). It includes all methods of concentrating, diverting, collecting, storing, and utilizing and managing runoff for productive use.

Rainwater harvesting is the process of interception and concentration of rain water and its subsequent storage in the soil profile or in artificial reservoirs for crop production. Thus it broadly includes roof water harvesting, run-off harvesting, and floodwater harvesting and sub-surface water harvesting (Finkel Segerros, 1995 in Getachew, 1999). The process is distinguished from irrigation by three key features: the catchments area is contiguous with the cropped area and is relatively small; the application to the cropped area or reservoir is essentially uncontrolled; and water harvesting can be used for various purposes other than crop production.

According to various authors cited in Reij, et al. (1988), some terms precisely explain the source of runoff. Thus the terms "rainwater harvesting," "rain harvesting", "rainwater collection" and "rainfall collection" are used. Like "Water harvesting" these terms are hydrological terms. The term rainwater harvesting agriculture (Bruins et al., 1986) expresses both the source as well as use of runoff. It is basically a hydro-agronomic term.

Another important factor is the form of runoff harvested. Different terms are used to describe the running off water from an area. The term "runoff" is a collective term and refers to over surface and/ or under subsurface runoff to reach the sea (Strahler and Strahler, 1976, in Reij et al., 1988). Although water harvesting is defined in various ways by different authors, there is a general consensus from the literature that the following are the major characteristics of water harvesting (Oweis et al, 1999).

1. Water harvesting is applied in arid and semi-arid regions where runoff often has an intermittent character. Because of the ephemeral of flow, storage is an integral part of water harvesting systems.

2. Water harvesting is based on the utilization of surface runoff, and requires a runoff producing and a runoff receiving area.

3. Most water harvesting systems use water near where it falls. They therefore do not include the storing of water in large reservoirs or the mining of ground water.

4. Water harvesting system is relatively small-scale operations in terms of catchment area, volume of storage, and capital investment.

RWH systems operate at different scales such as household, field and catchments level and can affect water availability and management for downstream and natural ecosystems like wetlands and swamps, due to the reduction of the catchments water yields.

2.2. Rationale and Significance of Rainwater Harvesting

2.2.1. The Rationale of RWH

Recent research results indicate that incorporating RWH in situ, supplemental irrigation and conservation tillage can increase water productivity (Rockstorm et. al. 2001), and food security. Therefore, incorporating RWH with land husbandry enhances soil infiltration, water holding capacity and water use efficiency at farm level.

Therefore, to upgrade rain fed agriculture in the SASE, attention should be given to rainwater harvesting, utilization and management due to the following reasons:

- 80% of agricultural land worldwide is under rainfed agriculture with generally low yield levels and high on farm water losses (Rockstrom et al., 2001)
- 95% of the current population growth occurs in developing countries which depend on rainfed –based rural economy (FAO, 2002 and UN, 2000)
- In SSA, rainfed- based rural economies generate 30-40% of countries' GDP (World Bank, 1997)
- Rainfed agriculture will remain the dominant sources of food production during the foreseeable future (Parr et al., 1990)
- Probably more than 90% of food consumed in SSA is from small scale rainfed agriculture (Savenije, 1999)
- Yields from rainfed agriculture are often low, generally around 1 ton/ha in the ASALs (Rockstrom, 2001)
- Rainfed agriculture is estimated to contribute 60% of world's crop production (FAO, 2002)
- Rainfed agriculture covers more than 95% of croplands in water scarce tropical regions of SSA (FAO, 2002)

- Low productivity in rainfed agriculture is due to sub-optimal performance related to management aspects rather than low physical potential (Rockstrom and Falkenmark, 2000 and SIWI, 2001)

- 44% of the land surface in SSA is subjected to high risk of meteorological droughts (Barrow, 1987)

- It is estimated that 200- 500 million cubic meters of rainfall is lost in the form of runoff in SSA every year, which could potentially irrigate up to 40,000 ha (Ben Asher and Berliner, 1994)

2.2.2. Significance of RWH

As water becomes more and more scarce, there is a need for an integrated approach to water management that encompasses all water users, types of water uses and sources of water. Water management, however, can never be an end in itself, it is an integral part of farm and land husbandry practices and its objective should always be to protect and improve the land- users' situation (LEISA, 1998). Nevertheless, high- external input techniques may be too expensive for smallholders or are inappropriate to local biophysical and social conditions. Many land-users would benefit from low- cost techniques more suited to their conditions and needs, and which also ensure an increased water use efficiency and conservation. It is encouraging that land-users have developed many low cost water saving techniques. Although most of these innovations remain unrecognized, many of them are within the reach of the land- users. Therefore, according to LEISA (1998), water scarcity can be challenged.

A review of promising low input technologies for SSA by the US Office of Technology Assessment rates RWH as the top option in terms of effectiveness and potential adoptability (Patrick, 1997). One of the great advantages of RWH is its potential risk mitigation effect by integrating spatially and poorly distributed rainfall and by making maximum use of the rains in spite of their poor temporal distribution, which extends the cropping season and spreads labour demand peaks (Patrick, 1997). Although the potential of rainfed food production is enormous, rainfed agriculture has been marginalized by water resources planners, who are mostly engineers (Savenije, 1999) biased towards the technically more challenging irrigated agriculture, and overlooking RWH technologies. However, because of their small scale, these techniques may be viewed by some as unlikely to have a significant impact in the foreseeable future on incremental food production in SSA (Rosegrant and Perez, 1995).

Rainwater harvesting can be viable in areas with 300 mm annual rainfall (Kutch, 1982). However, Pacey and Cullis (1986) gave a more conservative annual rainfall that range from 500- 600 mm. But, Kutch (1982) further stated that annual rainfall is not the most important criterion. Nevertheless, the technology has been used to sustain food production in the Negev desert of Israel with meager annual rainfall of about 100mm (Shanan and Tadmor, 1976). Ironically, most of the famine stricken areas of Africa receives much annual rainfall more than 100mm.

Therefore, the promotion of RWH should consider the perceived low rates of financial investments, especially in runoff farming, compared to irrigated agriculture. RWH minimizes some of the problems associated with irrigation such as competition for water between various uses and users, low water use efficiency, and environmental degradation. It is a simple, cheap and environmentally friendly technology, which can be easily managed with limited technical skills. The technology can also be integrated with many land use system, hence it is appropriate for local, socio-cultural, economic and biophysical conditions. Furthermore, there are many traditional water management techniques still being used to make optimal use of available rainfall (LEISA, 1998).

2.3. Rain water Harvesting Systems and Technologies

The various methods of collecting and concentrating surface runoff are classified in different ways by different authors, and the categorization chosen often reflects systems used in their countries of concern (Reij, et al., 1988). A few examples are described below:

Critchley (1987) classified water-harvesting systems based on the characteristics of catchment areas and storage components. He identified three sources of water that incorporates water from rooftops (rooftop harvesting), from overland and rill flow (runoff harvesting) and from channel flow (floodwater harvesting), and two types of storage such as long-term storage, which has high water depth and short-term storage, which is storage in or just above the soil profile. Short-term storage techniques are mostly used for plant production, whereas long-term storage aims at water supply for domestic and other purposes. However, Matlock and Dutt (1986) classify water harvesting according to the form of runoff and how the water is conveyed and identified three main types of water harvesting.

a) Water spreading: water from ephemeral flows is spread onto the flood plain of the stream for plant production.

b) Water diversion: water is diverted from an existing ephemeral stream and channel to a nearby cultivable area.

c) Micro catchments water harvesting: catchment areas immediately adjacent to a cultivable area or a storage facility are prepared or treated. According to Mattlock and Dutt (1986) water harvesting systems can also be classified according to their principal purpose or use, namely, for:

i) Crop production systems;

ii) Forage production systems

iii. Domestic and Livestock water system and

iv). Conservation systems.

Bruins et al. (1986) based their classification of runoff farming systems on geomorphology. They distinguish five types of systems and able to describe starting from the smallest geomorphologic scale to increasingly the larger systems:

A. Micro catchments systems: These systems have a runoff flow trajectory of less than 100m from the runoff contributing area to the receiving area.

B. Terraced wadi system: This involves the building of a series of low check dams across a wadi to retain the runoff water in the stream channel and enable the water to be stored in the Wadi soil.

C. Hillside conduit system: Runoff water is harvested on the upper and middle part of the hillside slope and directed by means of conduit channels onto agricultural fields and other storage reservoirs.

D. Liman system: A check dam of stone or earth is built, surrounding the arable land to retain runoff water from the wadi. A spillway regulates the level of the water in the liman to prevent the destruction of the check dam.

E. Diversion system: Runoff floodwaters in a wadi are raised by structures built in the wadi and diverted onto adjacent fields situated at an elevated position with respect to the streambed of the Wadi.

Another example is the classification of Bores and Ben-Asher (1982), which split rainwater-harvesting methods into two groups:

A. Micro catchments water harvesting (MCWH): This is a "method of collecting runoff from a contributing area over a flow distance of less than 100m and storing it for consumptive use in the root zone of an adjacent infiltration basin."

B. Runoff farming water harvesting (RFWH): A method of collecting surface runoff from a catchments area, using channels, dams or diversion systems, and storing it in a surface reservoir or the root zone of a farmed area for direct use.

Rainwater harvesting refers to the practice of collecting precipitation from small/large catchments and directed through channels to a storage facility or to a near by field or retained in-situ (Getachew, 1999). Rainwater harvesting is an opportunity for increasing water supplies. Rainwater is collected from hill slopes and man-made catchments that can create new supplies of low-cost high quality water for the area. Rainwater harvesting is particularly suited to supplying water for small village households, small gardens, livestock and wildlife (Zewdie, 1994)

Traditional water harvesting systems are characterized by flexibility and endurance and are strongly associated with the people who live in marginal environments. Thus, different areas will have different techniques for harvesting and applying water. Although the potential for water harvesting has not been fully assessed, this potential probably is quite large in the Greater Horn of Africa, where food security is a major concern.

Recently, renewed interest has been shown in water harvesting in Sub- Saharan Africa, probably as a result of increasing pressure on land, which forces more and more people to live in dry areas (Oweis et al., 1999). This new trend could also be attributed to failure of more conventional methods and changing environments forcing people to adopt new survival strategies. Therefore, water harvesting has a high potential for improving food security and reducing over-dependency on food aid. However, for this potential to be realized, appropriate techniques need to be identified for particular areas within the region. The case studies will contribute towards identifying different techniques of land-users in the region, and look into ways of improving the adopted technologies.

The term RWH is used in different ways and thus no universal classification has been adopted. To avoid further confusion, and facilitate the presentation of various types of RWH technologies and systems, the classification, based on runoff generation process, type of storage and size of catchments is adopted. The runoff generation criterion yields two categories – runoff farming where runoff is generated and in-situ water conservation in which rainfall conserved where it falls.

The runoff storage criteria also yield two categories – soil profile storage and distinct storage structures for supplemental irrigation, livestock, domestic or commercial use. Whilst the size of catchments criteria yields three categories – macro- catchments, small external catchments and micro catchments etc.

The following sub-sections highlight some of the RWH systems and technologies that have been tried, experimented and practiced in different parts of Sub- Saharan Africa, in addition to those identified and evaluated as part of the GHARP case studies in parts of Ethiopia, Kenya, Uganda and Tanzania.

2.3.1. Runoff – based RWH Systems

The runoff- based RWH systems, which entail runoff generation either within field or from external catchments and subsequent application either directly into the soil profile or through temporary storage for supplemental irrigation, are classified according to two criteria: runoff storage and size of catchments. Classification of runoff- based rainwater harvesting technologies depends on:

Source of runoff (external) or within-field catchments

Methods of managing the water (maximizing infiltration in the soil, storing water in reservoirs and inundating cropland with floods)

Use of water (domestic, livestock, crop production, gully rehabilitation, etc.)

- **Storage RWH systems**

RWH systems with storage for supplemental irrigation are becoming popular in semi-arid in Machakos, Laikipia, Nakuru and Kitm districts of Kenya. They are also introduced in Ethiopia around Nazareth on experimental basis by RELMA (Nega and Kimeu, 2002). Initial results from RWH experiments in Machakos district, which focused on the feasibility of using earth dams for supplemental irrigation of maize have been encouraging (Rockstrom et al., 2000). The main challenge with this initiative is to assess whether it is possible to design simple and cheap earth dams or farm ponds that could permit gravity-fed irrigation to reduce the cost of lifting water.

RWH storage systems offer the land- user a tool for water stress control – dry spell mitigation. They reduce risks of crop failures, but their level of investment is high and requires some know- how especially on water management. However, these systems also to some extent depend on rainfall distribution. During extreme drought years, very little can be done to bridge a dry spell occurring during the vegetative crop growth stage if no runoff producing rainfall has fallen during early growth stages. Under normal intra-seasonal droughts, the farmer will be assured of a better harvest and hence it is worth investment in RWH to improve crop production in the semi-arid tropics of SSA. Nevertheless, location of storage structure with respect to cropland needs to be addressed. Conventionally, the reservoirs are located downstream, thus requiring extra energy to deliver the water to the crops. However, it would be more prudent to locate the reservoir upstream of the cropland to take advantage of gravity to deliver the water (Rockstrom, 2001).

Runoff is collected from grazing land, uncultivated land, cultivated land and /or road drainage and directed into small manually constructed reservoirs (50-200m^3). The stored water is mainly utilized for kitchen gardening and establishment of orchards. This technology was introduced in Laikipia district Kenya in the late 1980's by the Anglican Church of Kenya and has shown promising results. It has been promoted by Dutch-supported ASAL and SARDEP progammes with limited success due to seepage related problems. Various remedies are being tried to reduce seepage to realize maximum benefits from this technology. In Kenya, it has also been introduced in Machakos district by RELMA. Optimal benefits could be realized if appropriate water lifting and application technologies such as treadle pump and drip irrigation are incorporated. Farm ponds have also been used for watering livestock.

Other storage systems used by small scale farmers in semi-arid districts of eastern Kenya are rock catchments/ dams, sand dams and sub- surface dams (Petersen, 2000; Thomas, 1999; Gould and Petersen, 1999; Pacey and Cullis, 1986). Sand dams and subsurface dams are barriers constructed across sandy riverbeds--a common feature of most semi-arid environments– to retain water within the trapped sand upstream. These systems have provided water for decades especially in Machakos district of Kenya and Dodoma area of Tanzania but their potential has however, not been widely recognized. The impacts of sand dams on food security have been highly precarious (Isika et al., 2002). They are mainly used for domestic purpose (Rockstrom, 2001).

Rock catchments dams are masonry dams, for capturing runoff from rock surfaces/ catchments, with storage capacities ranging from 20-4,000 m^3. They are generally used for domestic purposes, but can also be used for kitchen gardening, for example in Kitui district (Ngure, 2002).

At community level, earth dams or water pans are constructed to store large quantities of water, especially for livestock and small- scale irrigation. These water pans and earth dams are the lifeline for livestock in the ASAL of Kenya, Somalia, parts of Uganda and Ethiopia. The earth dams were introduced in Kenya by white settlers while the water pans have been traditional sources of water for example, hafirs (water pans) in North Eastern province of Kenya, parts of Somalia and western Sudan (Critchley, 1987).

Concrete/ mortar lined underground tanks (100-300m^3) are used for domestic and some livestock such as milking cows and calves or weak and sick animals, separated from the main herds) in Somaliland (Pwani, 2002). In addition, excavated pits or ponds sometimes called charco-dams, both for domestic and livestock water supply, which are constructed in relatively flat topography, are common in Shinyanga, Dodoma, Arusha, Singida and Mwanza regions (Hatibu et al., 2000).

2.3.2. Direct Runoff Application Systems

This category of RWH technology is characterized by runoff generation, diversion and spreading within the cropland, where the soil profile acts as the moisture storage reservoir. This technology is further classified, according to size of catchments: macro-catchments systems, or spate irrigation – large external catchments producing massive runoff, and small external catchments like road drainage, adjacent fields, etc.

Flood diversion and spreading (spate irrigation) refers to RWH system where surface runoff from macro- catchments concentrating in gullies and ephemeral water courses is diverted into the cropped area and distributed through a network of ditches and subsequently retained in the field by ridges. It entails controlled diversion of flash floods from denuded highlands to cropped land well prepared to distribute and conserve moisture within the plants' root zone. The rainfall characteristics in the semi- arid savannah environment occurs as high intensity storms that generate massive runoff that disappears within a short period through seasonal waterways. Extensive flood irrigation of paddy rice in cultivation basins are created from 25- 100 cm high earth bunds, is practiced in semi- arid central parts of Dodoma, Singida and Shinyanga in Tanzania (Hatibu et al., 2000 and Lameck, 2002).

Spate irrigation in northern Ethiopia and Eritrea, involves capturing of storm floods from the hilly terrain and diversion into leveled basins in the arid lowlands for crop production. In Kobo Woreda, South Tigray, spate irrigation is well developed with main diversion canals, secondary, tertiary farm ditches which distribute flood water into cultivation basins with contour bunds to enhance uniform water application. The system has also been tried in Konso, southern Ethiopia. This technology has also been practiced in Turkana district, Kenya and parts of Sudan for sorghum production (Cullis and Pacey, 1992). In western Sudan, terraces and dykes are used for spreading runoff from wadis onto vertisols (Critchley, 1987). The potential of these systems are enormous and if improved and promoted could lead to food security.

Small external catchments systems include a form of small scale runoff diversion and spreading either directly into cropland or pasture through a series of contour bunds or into terrace channels and other forms of water retention structures. The runoff is either conveyed through natural waterways, road drainage or diversion drains. Footpath runoff harvesting is practiced in parts of Kenya (Machakos, Kitui and Laikipia), in which flood water from road drainage is diverted either into storage for supplemental irrigation or into croplands using wild flooding, contour bunds, or deep trenches with check-dams to improve crop yields. A similar system is practiced in southwestern Uganda, where runoff from gullies, grazing land, or road drainage is diverted into banana plantations (Kiggundu, 2002).

The terraces are modified by constructing planting pits mainly for bananas and tied ridges for controlling the runoff. Runoff spreading has also been accomplished by contour bunds in Laikipia district in Kenya. They collect and store runoff from various catchments including footpaths and road drainage. The stored runoff seeps slowly into lower terraces ensuring adequate moisture for crops grown between the terrace channels. In southern Uganda, a similar system has been adopted, on which contour ridges tied at regular intervals are used in banana plantations. The runoff from hilly grazing lands is distributed into the banana plantations by contour ridges. Agro-forestry is also incorporated, where trees are planted on the lower side and giant Tanzania grass is planted along the ridges. This system has tremendously improved the yield of the bananas and has enhanced zero grazing. Contour ridges and infiltration trenches have also been adopted to improve pasture in southern Uganda (Kiggundu, 2002). In the eastern part of Sudan, a traditional system of harvesting rainwater in "terraces" is widely practiced (Critchley, 1987). It consists of earth bunds with wing walls which impound water to depths of at least 50 cm where sorghum is planted. Within the main bund there may be smaller, but similar bunds, which impound less runoff on which planting can be done earlier.

2.3.3. Micro-catchments systems

These involve runoff generation within the farmer's field and subsequent concentration on either a single crop especially fruit trees or a group of crop with alternating catchment. A number of within- field RWH systems fall under this technology, in which crop land is sub-divided into micro- catchments that supply runoff either to single plants (pawpaw or oranges) Negarims in Kitui, Kenya for a number of plants (maize and sorghum) in case of chololo pits in Dodoma, Tanzania. Pitting techniques, which has shallow planting holes < 25 cm deep are dug for concentration of surface runoff and crop residue, are found in many farming systems throughout SSA. They have different names in many areas zai pits (Burkina Faso), matengo pits (southern highlands to Tanzania) and tumbukiza for Napier grass and banana or pawpaw pits (Kenya). Moisture retention terraces and ditches are other micro- catchment techniques promoted and adopted in SASE. The following are more examples:

• Fanya juu terraces, which are made by digging a trench along the contour, and throwing the soil upslope to form an embankment. They have made a very significant impact in reducing soil erosion in semi- arid areas with relatively steep slopes (Thomas, 1997 and Tiffen et al., 1994). They have been used for RWH by incorporating tied ridges in the channel with closed outlets.

• Fanya chini, in which the soil is thrown down slope instead of upslope, was developed in Arusha region, Tanzania.

• Contour bunds which include stone bunds and trash lines in dry areas of southern Kenya and retention ditches and stone terraces in Ethiopia are also employed. Yields of sorghum are reportedly increased by up to 80% using contour bunds in northwestern Somalia (Critchley, 1987).

• Micro- basins, which are roughly 1.0 m long and < 50cm deep, are often constructed along the retention ditches for tree planting in northern Tigray, Ethiopia (Lundgren, 1993). Sweet potato ridges in southern Uganda fall under this category (Kiggundu, 2002). In Kwale district of Kenya, tied ridges and small basins have been reported to improve maize yields by more than 70%.

• Large trapezoidal bunds have been tried in arid areas of Turkana district, northwestern Kenya for sorghum cultivation and, trees and grass planting (Thomas, 1997).

•Infiltration trenches intervals according to the slope were used, for retaining runoff in banana plantations in Mbarara and Rakai districts of southwestern Uganda, (Kiggundu, 2002).

• Circular depressions with a diameter of 3-4m and depth of 1 m are practiced in southern Ethiopia to cultivate a variety of crops.

2. 4. Enhancing Rainwater Harvesting Practices

Rainwater harvesting is feasible wherever runoff from rainfall can be collected. However, it is most applicable in arid and semi-arid regions where agricultural production is limited primarily by meager and erratic rainfall (FAO, 1994:385).

According to FAO (1994), rainwater harvesting would be beneficial:

•To supplement existing and limited irrigation water resources such as springs and wells,

•To counteract the low reliability and high variability of rainfall and rain fed agriculture in arid and semi-arid regions,

•To increase the production and productivity of existing rain fed agriculture,

•To meet the increasing demand for agricultural food products and the increased pressure on existing cultivated land and water resources,

•To make more efficient use of available unused agricultural resources.

2. 5 Magnitude and Causes of Food Insecurity in Ethiopia

2.5.1 The Concept of Food Security/ Insecurity

Food security is defined as physical and economic access by all people at all times to sufficient food to meet their dietary requirement for a productive and healthy life (ILRI, 2002). According to the UN (1990) household food security is defined as "the ability of household members to assure themselves sustained access to a sufficient quality and quantity of food to active and healthy lives." The food security at the household level indicates the ability of the household to secure enough food that ensure adequate dietary intake for its members. Besides, the definition emphasizes on access to food at household level as compared to availability at a national level.

The general notion of food security has been developing and gained wider attention since the early 1970s and 1980s (Day, 1994). This is due to the result of debates on the question of "access to food". Currently, the central focus on the unit of analysis shifted from the global and national to household and individual levels. Food security is an idea that can generally be addressed at the global, regional, national, community, household and individual levels. As Hubbard (1995) indicates, household food insecurity can exist even where there is national food security. Crises of national food security are usually started by the widespread losses of household food security; for example, following crop failure. Logistical and distribution failures are at the center of national food security crisis and cause the inability to relieve household food insecurity even where there is sufficient food available in the country to do so. This day, increasing attention has been paid to household and individual level food security because of the growing understanding that, expanded food production, food supply and sufficiency at macro-level will not ensure that all families and individuals will be able to secure their food needs (Day, 1994).

Food security requires a multi-dimensional consideration since it is influenced by different interrelated socio-economic, environmental and political factors (IFAD, 1992).The state of household food security is mainly conditioned by factors, which are related to the process of food acquisition, household procurement strategies and socio-economic conditions of the society.

Food security is generally affected by two major determinants: availability of food, and access to food. The former is further influenced by the different sources of food and handling patterns which facilitate the time dimension of food availability in the household, while access to different resources and the pattern of social support have greater impact on the procurement strategies of food supplies. The resources like cash, labor, land market and public services determine the possibility of increasing entitlement to food. Efficient allocation and use of resources significantly determine the process of securing stability in food chains. Particularly, availability of food in the market is highly influenced by the efficiency of the marketing channels, information systems and development of infrastructures (Mulat et al., 1995).

According to Mulat et al., (1995) the economic structure and political conditions of a given country highly determine the food situation in a household. Policies, for example, which affect the variability of food production and acquisition directly, influence the changes in the level and patterns of food intake at a household level. Moreover, the international economic environment affects the realization of household food security.

In contrast to "food security", the term food insecurity could be defined as the lack of access to enough food both in quantity and quality on a sustainable basis. In some cases, there may not be enough food at the time and location required to fulfill the needs of all members of the community, at the nation, region, village or household (Day, 1994). According to Maxwell (1992), food insecurity is defined as "a situation in which individuals of a society have neither the physical nor the economic access to the nourishment they need." It is closely associated with poverty (World Bank, 1998).

Food insecurity is often classified into two types: Chronic food insecurity which shows the long term shortage of food; and transitory food insecurity which refers to the temporary shortage of food (EEA, 1999/2000).

2.5.2 Magnitude of Food insecurity in Ethiopia

The country's chronic food insecurity is the result of cumulative effects of various factors that have been increasing in magnitude over many years. Some of the major factors contributing to the current food insecurity include widening gap between the level of food production and rapid population growth, degradation of natural resource base, dominance of crop farming which is exclusively dependent on rain- fed cultivation together with the erratic and unreliable nature of the rainfall pattern that led to poor agricultural production.

As Gezahegn et al., (2003:87) point out, food insecurity in Ethiopia has both chronic and transitory nature. Based on annual report of the government, within seven years from 1995 to 2003 time some 4.3 million people were affected by permanent food insecurity problems in Ethiopia. In addition to this, millions suffer from temporary food insecurity. Most of the chronic food insecure households live in 155 Woreda in Amhara, Southern peoples, Tigray, Somali and Oromia regions. Vulnerability to temporary food insecurity varies from year to year, depending on coverage and magnitude of drought. For example, total number of chronic and transitory food insecure people reached 12 million in 1984 and 10 million in 2000. If 4.3 million were affected by chronic food insecurity, the remaining 6 to 8 million were affected by transitory food insecurity.

As shown in Table 2.1 food aid requirement varied between 492,000 MT to 898,936 MT though there had been a slight decreasing of food aid requirement in the years 1996 and

1997. The demand of food aid increased from 4 million to 12.1 million consistently from 1995 to 2003 only with the exception of 1996 and 1997.

It is not unusual at present to hear estimates that over half of the Ethiopian population may in fact be chronically food insecure. Those mainly affected are households suffering from land scarcity or shortage of draught animals, cash to buy inputs and a significant percentage of landless, elderly, disabled, female headed, poor pastoral and newly established households (Yared, 2001).

Table 2.1. Crop Production and Food Aid Requirements of the Ethiopia Population (1995 –2000)

Year	Estimated Crop Production (million MT)	Estimate of Food Aid Requirement (MT)	Estimate of Needy Population
1995	10.2	492,000	4 million
1996	11.8	262,000	2.7 million
1997	8.8	329,000	3.4 million
1998	11.3	602,000	5.3 million
1999	10.7	460,000	6.6 million
2000	-	898,936	(10) 7.7 million
2003	-	-	12.1 million

Source: Yared Amare (2001:38); Annual report of DPPC; Gezahegn, et al (2003:86)

The extent of food insecurity, the volume of food aid in response to emergency needs and program has increased by 2.3 % per annum. The volume of food aid has increased from 200,000 MT in 1980's to 1.2 million tons in 1999 (Debebe, 2001).

In examining causes of food insecurity, it is useful to distinguish between long-term trends which shock the food of individuals and households, and nations. In Ethiopia, poor agricultural growth, unequal distribution of productive resources and income, rapid population growth and urbanization are the underlying causes for the growing chronic food insecurity and poverty problems (Day, 1994). So far, chronic food insecurity affects the population that persistently lacks the ability either to buy enough food or to produce their own.

On the other hand, transitory food insecurity is often trigged by seasonal instability in food supply or availability, fluctuations in food prices and /or incomes, which themselves may result in periodic variations in individual food consumption and nutritional status and in its worst form, it produces famine (Day, 1994).

According to Day (1994), the specific causal factors of transitory food insecurity are:

- Rain failure at critical times in the agricultural cycle such as in crop planting and/or flowering stages,
- Human and animal disease outbreaks,
- Hailstorm, flood and related hazards leading to serious harvest failure and livestock loss,
- Sharp increase in grain price coupled by sharp decrease in livestock prices,

- Declining/lack of purchasing power;

- Decline in food availability in local markets; and

- Declining or lack of labor demand during crisis situations, which further aggravates the magnitude of household food insecurity.

- Recent studies (Dagnew, 1993) indicate that the lowlander peasants and pastoralists are particularly vulnerable to the recurring disaster-induced food shortages and famines that have mainly been induced due to drought, disease and pest outbreaks.

2.5.3. Causes of Food Insecurity in Ethiopia

2.5.3.1. Uneven Distribution of Rainfall

The natural resource potential of Ethiopia is high in supporting far greater number of people (MoWRD, 2000 and Alamerew, 2001). Nevertheless, the uses of the water resources of Ethiopia to meet the socio- economic needs of the country and its people are very limited due to various constraints. The major limitation lies in the uneven distributions and mismatch of the available water resources with respect to the agro-ecological and settlement patterns in the country. Moreover, despite Ethiopia's plentiful annual rainfall on the average, it falls either too early or too late with a characteristic of high intra- and inter-annual variation in quantity as well as in terms of the spatial and temporal distributions of the seasonal rainfall. Annual rainfall in the country ranges between 2700 mm in the south-western highland and less than 200 mm in some parts of the northern and south-eastern lowlands with a further decrease to 100 mm in the north-eastern lowlands. The southern, central, eastern and northern highlands of the country have a bi-modal rainfall pattern while the south-western and western areas are characterized by a mono-modal rainfall.

Ethiopia has five major agro-climatic zones, which are broadly defined on the basis of altitude r anges (Hurini, 1 986). T hese a re Berha (< 5 00 m asl), K olla (500- 1 500 m asl) Weyna-Dega (1500-2300 masl), Dega (2300- 3200m asl) and Wurch (>3200 masl). Because of the favorable climate and absence of many tropical diseases, the highlands of Ethiopia are favored for settlement. The Ethiopia highlands (above 1500 masl) harbour about 88% of the human and 65% of the livestock population (Huirni, 1986).

As the population density in the highland areas continued to increase more and more marginal lands were put under cultivation which eventually resulted in the severe degradation of agro-ecological resource bases and declining agricultural production. Consequently, population expansion increased towards the extensive arid and semi-arid lowland areas. Unfortunately, these areas are usually constrained by, among other things, shortage of rainfall for optimum agricultural production. This calls for the use of suitable technologies for improved and sustainable agricultural production (MoA, 2001). Available information indicates that nearly 70% of the total arable land in Ethiopia receives annual rainfall of less than 750 mm. the areas with annual rainfall of 500-750 mm are believed to support optimum level of agricultural activities, if the annual rainfall distribution is undisturbed and proper land management is applied. Therefore, overcoming the limitations of these arid and semi-arid areas and making good use of the vast agricultural potential under the Ethiopia context, is a necessity rather than choice. Therefore, there is need for appropriate interventions to address the prevailing constraints.

2.5.3.2. Drought

There is no single definition of drought (CRDA, 1998). There are many definitions. It is defined as "the lack of rain over long period of time" (MOE, 2000), lack or insufficiency of rain for an extended period (Encyclopedia of Britannica, 1997) and a condition in which people literally consume themselves to death (Mesfin, 1985)

Drought has been the major immediate cause of food insecurity in many regions of Ethiopia. At the household level in particular the recovering of food production and livelihood systems has been undermined in many cases by years of drought, leading to depletion of family assets and the erosion of community social security structures (Day, 1994).

During the 1984/85 famines alone, the country has witnessed the death of nearly one million people due to starvation. In fact, the Ethiopian peasant has endured probably the largest number of recorded famines in Africa through the centuries (Markos, 1997). Drought has been the experience of ancient and contemporary Ethiopian history. But there has not been a time at which millions of peasants have been exposed to famine on such a large scale and at such an increasing frequency as in the last three decades. Drought has long-term effects in reducing the economic base of households, thereby leading to chronic and acute food insecurity.

According to UN (2000), there were serious droughts and starvation in 1973/74, 1984/85, 1987, 1992-1994, 1999/2000, and 2002/03 in Ethiopia. In Ethiopia, there is a strong interdependence among drought, environmental degradation and poverty. Land degradation causes decline in productivity of land. This results in shortage of food crops and livestock. The occurrence of drought causes famine and starvation, which are the reflection of poverty (Dagnew 1994). The major droughts in Ethiopia since 1800 are listed in table 2.2

Table 2.2 Drought events in Ethiopia since 1800: Year of Occurrence, Area affected and Consequences.

Year of occurrence	Area Affected and Consequences
1800	• Tigray and adjoining areas of the north and east of the province. • Smallpox epidemics and other diseases had caused much of the deaths.
1835-37	• Northern Shewa, Wollo and Tigray. • The famine and its ensuing • Cholera epidemic caused widespread deaths.
1865-67	• Tigray and the province of Begemidir • Outbreak of cholera, widespread deaths and social dislocation.
1877	• Northern parts of the country (Tigray and northwestern Wollo) • There were widespread diseases and 'daily deaths,' and was very severe.
1888-92	• Great famine of Northeast Africa • Hunger, cattle diseases and epidemics for nearly half a decade that may have wiped out the country's population.
1913-14	• Tigray province and Northern Wollo. • Food shortages in Northern Wollo and Central Tigray up to the end of the decade.
1920-21	• Northern parts of the country. • Poor harvests due to lack of rain in those years.
1953	• Wollo and Tigray. • Famine was exacerbated by drought.
1964-66	• Many parts of Wollo and Tigray. • Many thousands of deaths and livestock losses.
1973-74	• Northeast and eastern Harar province, eastern Sidamo province, eastern Gamo Gofa and the lowland areas of Bale. • Drought deaths and deprivation to the pastoralist and semi-pastoralist people, and the death toll estimated at 100,000 to 200,000.
1984-85	• Almost all of the country except few areas. • Many deaths occurred that estimated at 100,000 to 500,000.
1987	• Tigray, Wollo and parts of Gonder. • Food crisis due to lack of sufficient rainfall (drought).

Source: Markos Ezira, 1997

Generally, from Table 2.2, it can be summarized that Tigray and Wollo were the most affected areas in the country and famines have always left a lasting memory on the social scene in Ethiopian history.

2.6. Rainwater Harvesting in Ethiopia

The history of water harvesting in Ethiopia dates back to the pre-Axumite period (560 BC). Harvested rainwater was used for agricultural and water supply purposes. Fattovich (1990) indicates that there is documented evidence of the remains of ponds that were once used for irrigation during this period. A roof water harvesting set up is still visible in the remains of one of the oldest palaces in Axum, the palace of the legendary Queen of Sheba (Fattovich,1990). Other evidence includes the remains for one of the old castles in Gonder, constructed in the 15-16th century, which used to have a water harvesting set up and a pool that was used for religious rituals by the kings. In south of the country, the Konso people have had a long and well established tradition of building level terraces to harvest rainwater to produce sorghum under extremely harsh environment; low, erratic and unreliable rainfall conditions. It is indeed one of the wonders of this country, and it has been practiced for millennia; a symbol of struggle for survival by the Konso people against the adversaries of nature.

According to Fattovich (1990), there were over 2000 traditional ponds in Ethiopia (quite a small number compared to over 2 million ponds in the United States). They are used primarily for domestic water supply and livestock watering. The most common type of pond is the excavated type. The distribution of these ponds generally is in the arid and semi-arid areas, and traditional ponds are major sources of water in the rift valley where ground water is deep and other sources of water are not feasible.

Gabre-Emanuel (1997) points out that in Ethiopia, in general, the most common method of collecting rain water in the rural areas are the roofs and particularly in the southern regions, are by digging shallow ponds at carefully located and constructed points where runoff can be accumulated. This type of pond is a convenient and reliable source of water supply for small villages, households, livestock and vegetable growing.

CHAPTER THREE

3.0. GENERAL DESCRIPTION OF THE STUDY AREA

3.1. The Physical Environment

3.1.1 Location

The study was undertaken in Kalu Woreda of South Wollo Zone, Amhara Regional state. It is located 378 km to the north of Addis Ababa and 23 km south of Dessie. The Woreda has a total area of 113,008 km^2, and is divided into 35 rural Peasant Associations and 4 urban Kebeles. Kalu Woreda is adjacent to Albuko, Kombolcha, Dessie town, Dessie Zuria and Tehuledere woredas in the west, Worebabo Woreda in the north west, and Afar Region in the north east and Kemise-Oromiya Zone in the south and in the east. Among the 35 Peasant Associations, the study has been conducted in four Peasant Associations, namely; Bosena (09) which is located in Woina Dega agro ecological zone, Aba-Hilme (018), in the Kolla agro ecological zone, Abecho (019), in the semi-arid zone, and Wodajo (022), in the Kolla and dry dega zone of the Woreda. The detailed relative locations of the study woreda and the specific study sites/ Kebeles are indicated in figure Fig 3.2.

Figure 3.1 Location Maps of Ethiopia and the Amara Region

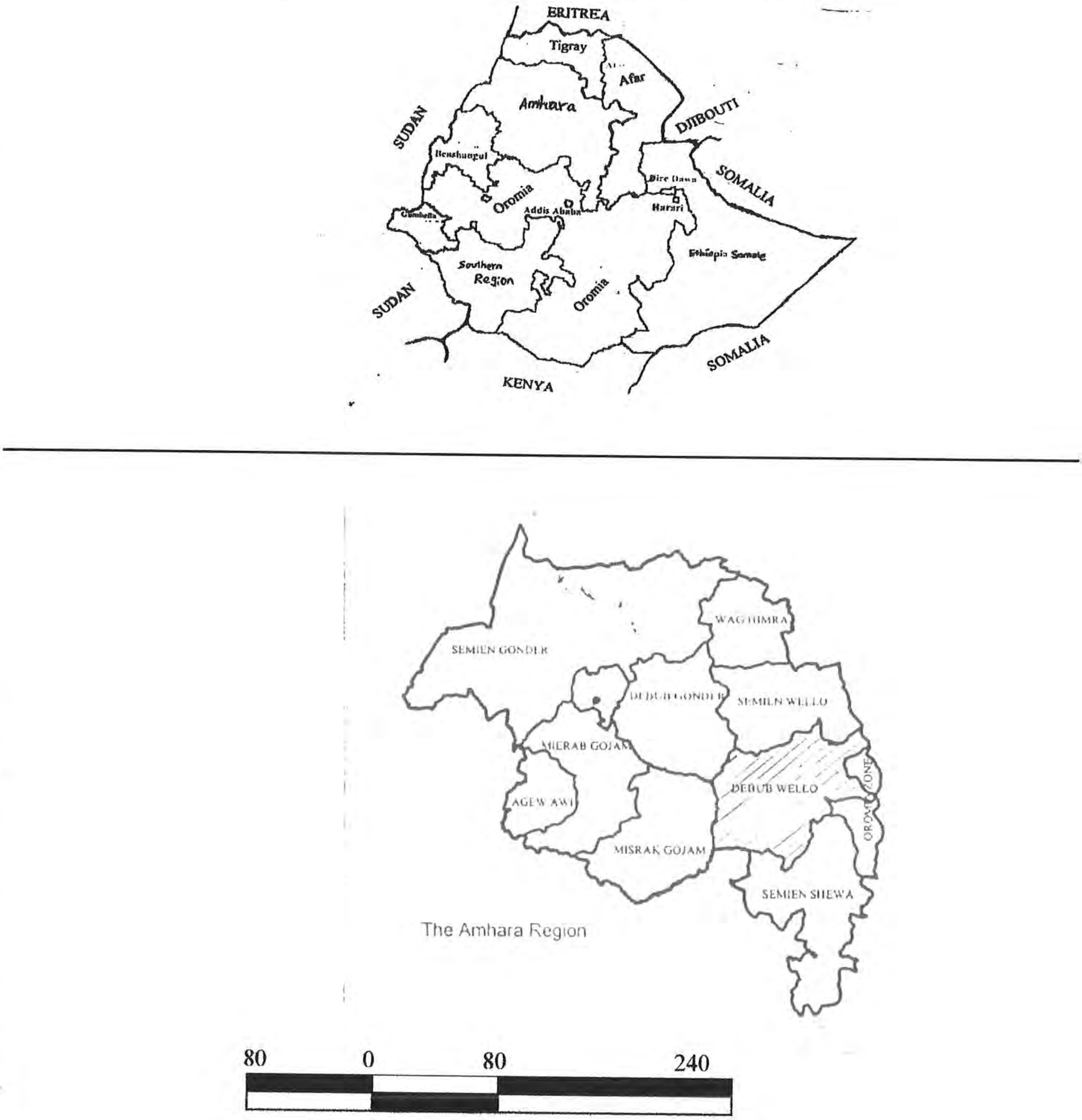
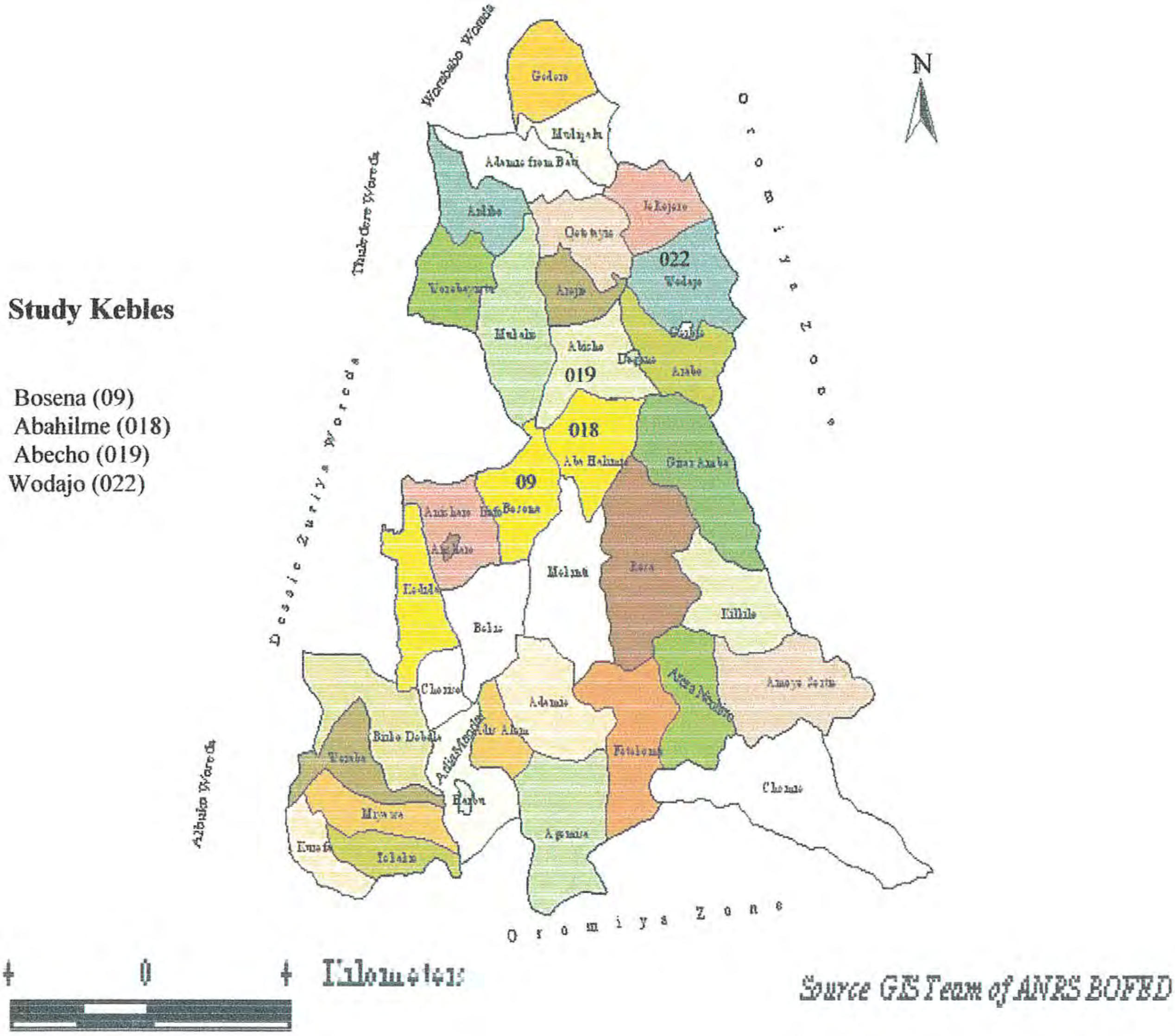


Figure 3.2 Location Map of Kalu Worda by Kebele



3.1.2. Topography and Climate of Kalu Wereda

The topography of the Wereda is mainly characterized by undulating hills with mountains and rugged terrain. It has 44.5% hill lands, 34.5% mountainous areas, 15.5 % rugged terrains and 5.5 % plain lands (Annual Report of Kalu Woreda Agriculture and Rural Development Office, 2004).

The Woreda lies between the altitude ranges of 1450 and 2680 m above sea level. Agro-ecologically, the Woreda is categorized into three agro climatic zones, namely lowlands (Kola, 43%), mid temperate highlands (Woina Dega, 38%) and extreme highlands (Dega, 19%). Kalu Woreda has a bimodal rainfall pattern and correspondingly two main cropping seasons, namely 'meher', which extends June to August ,and is the longest and intense rainy period. The other rainy season is the 'belg'. 'Belg' lasts from February to April. It is characterized by short and less intense rainy period. The remaining months are dry. The mean annual rainfall in the area is 1,043 mm (Annual Report Kalu Woreda Agriculture and Rural development Office 2004).

3.1.3. Land use and land cover of the Study Area.

Based on the data obtained from the Annual Report of the Woreda Agriculture and Rural Development Office (2004), the total area of the Wereda covers 113,008 ha, which is used for different purposes. Of these, 18,472.56 ha were used for crop cultivation, 4,988 ha for forest, (2,500 natural and 2,488 ha man-made), 82,485.44 ha for shrub and bush, 1,659 ha for grazing, 3,308 ha developed area, 1 ha water body while the waste land covers 2,094 ha.

3.2. The Socio-economic Profile

3.2.1. Population

Kalu Woreda has an estimated population of 260,000 people. Of this, 36,936 and 6, 593 were male-headed and female-headed households respectively. There were 112,017 male and 144,061 female populations in the study area.

3.2.2 Infrastructure and Social Services

A. Road, Electricity and Potable Water Servicess

The main road from Dessie to Afar Region and Assab passes across the Woreda. There are also rural road net-works that are constructed mainly by food-for-work and road construction programs in each Kebele Administration. The roads connect all Kebeles in the Woreda only during the dry season and have a total length of 259.8 km.

From the total 35 rural and 4 urban Kebeles of the Woreda, it was only 3 urban Kebeles namely Gerba, Degan and Harbu Kebeles were beneficiaries of electricity. The number of beneficiary people in these Kebeles was 19,358. Of these, 4,302 were living in Gerba, 5,043 in Degan and 10,013 in Harbu.

The beneficiaries of clean drinking water in both urban and rural Kebeles were 82597 people in 2003. Of which, 63,699 were in rural Kebeles while 18,898 were in urban Kebeles. Furthermore, a total of beneficiaries in 2004, both in urban and rural Kebeles were 105,459. Of these, 85,994 and 19,465 were found in rural and urban Kebeles, respectively.

B. Education and Health Services

In the Woreda there are 1 kindergarten school , 40 first and second cycle primary schools and 1 senior secondary school and about a total of 372 teachers in the primary schools while 15 teachers in the senior secondary school.

During the field work, there were 14 health institutions, of these, 1 was a health center, 6 were clinics and 7 were sub-clinics that are found in remote Kebeles. Some reports in the Woreda Health Office show that two clinics, namely Ketetia and Ancharo clinics were first established in the Woreda in 1976.

3.3. Crop Production and Livestock Tending

A. Crop Production

Agriculture is the most important economic activity in the Woreda. A large number of economically active populations engage in this sector to generate the source of their livelihood. Nowadays, subsistence - mixed farming prevails throughout the Woreda. Both crop production and animal husbandry typically practiced in very traditional agricultural methods. Cereals (Teff', wheat, millet, sorghum, barely, etc), pulses (beans, peas, chickpeas, lentils, etc), oil crops (Linseed, Niger seed, Sun-flower, etc) and spices (fenugreek, red pepper, black cumin, bishops weed, etc) are the main agricultural crops cultivated in the Woreda.

However, according to the results of the focus group discussion, peasant households in the study area are facing regular pest attacks that cause enormous damage on crops. Weeds, termites, weevils, worms and insect invasions have led to the decline of agricultural production from year to year.

B. Livestock Tending and its Constraint

The Woreda has an estimated number of 417, 382 livestock populations. The main types of livestock in the Woreda include cattle (oxen, cows, goats, and sheep), equines (donkeys, mules, horses) and pack animal (camel).

Since the past few years, the number of livestock population has increased from year to year. For instance, in 1999 and 2004, the total number of livestock was 277,761 and 417,382 respectively. This shows almost a double increase of livestock population which accounted a difference of 139,621 within a time of almost half a decade. As the 2000 Household Survey Report indicated, the main types of animal diseases in order of severity include:

- Cattle Diseases: Aba-senga, "Sanba-mich" and Aba-gorba.
- Equine Diseases: External parasites, "Sanba-mich" and internal parasites.
- Sheep and Goat Diseases: "Sanba-mich", "Ekek" and internal parasites.

C. Livestock Ownership

Livestock represent the most important resources of livelihood in the study area. Livestock are used as a source of draught power, social prestige, capital and food such as meat, milk, and butter and as buffer in times of stress. Ownership of livestock provides a good proxy for wealth and non-ownership is a straightforward indicator of impoverishment. In the study area ownership of a combination of oxen and cows are prime determinants for stratifying farm households into different wealth groups.

Owning at least a pair of oxen is vital to have the livelihood of the individual households. According to information obtained from focus group discussion, the livestock sub-sector, which is an integral component of the farming system, has a significant share in the asset base of farmers in the study area.

Table 3.1. Types and Number of Livestock in the Study Area

Type of Livestock	Livestock Number					
	1999	2000	2001	2002	2003	2004
1. Cattle	13920	10180	9085	-	9506	12046
Cows	4003	3105	3023	-	3690	3045
Heifers	1726	1287	1363	-	1291	800
Bull	1619	1150	1453	-	1246	607
Calf	2272	1362	-	-	1716	2524
Oxen	4227	3296	3246	-	1563	5070
2. Equines	1263	1490	893	-	1026	1581
Mule	133	165	79	-	83	73
Horse	88	71	54	-	56	26
Donkey	1115	1124	760	-	887	1482
3. Sheep & Goats	3432	3662	4276	-	5028	9261
Sheep	2383	2567	142	-	-	1500
Goats	1049	1095	4134	-	-	7761
4. Camels	81	87	78	-	1287	234
5. Chickens	9862	9913	7962	-	9251	23478
Grand Total	28558	25352	22294	-	26098	4600

Source: Annual Report of Kalu Woreda Agriculture and Rural Development Office (1999-2004)

As Table 3.1 indicates, the number of cattle in the four kebeles had been decreasing from year to year. However, the number of calves and oxen has shown an increasing trend from 1999 to 2004. The total number of cattle in the year 1999 was 13920 while it was 12046 in the year 2004. This again shows a decrease by 1874 cattle. On the other hand, between the same years the number of calves and oxen had increased by 252 and 843 respectively.

The total number of equines has increased from 1263 in 1999 to 1581 in the year 2004. Similarly, the number of donkeys grew from 1115 in 1999 to 1482 (33 percent) in the year 2004, while the number of mules and horses, on the contrary, decreased from 221 in 1999 to 99 (45 percent) in the year 2004. In the case of the numbers of sheep, goats, camels and chickens, there has been a considerable and continuous increase from year to year

Table 3.2 Ownership of Oxen in the Study area (1999-2004)

Number of oxen	Number of Households					
	1999	2000	2001	2002	2003	2004
0	2569	962	989	1125	1294	1880
1	1953	3255	3042	3015	3136	3341
2	486	454	425	254	332	1010
3	-	-	-	-	-	162
4	-	-	-	-	-	27
5	-	-	-	-	-	9

Source: Annual Report of the Woreda Agriculture and Rural Development Office (1999 - 2000).

As the above Table indicates, the number of farm households who had no ox were 2569 in 1999 and 1880 in 2004. Similarly, the number of households with one or two oxen has increased between 1999 and 2004.

3.4. Food Insecurity

Since 1 970s, t he W oreda h as b een f requently a ffected b y d rought. In t he W oreda, t he worst drought occurred in 1984/85, 1994/95, 1997 and 2001/02. Among these drought years, the 1984 and 85 r elated food c rises were the most disastrous, and many people were reported to have perished due to the greatest famine. In South Wollo, there are eighteen woredas with a total population of approximately 2,500,000 people. Of these, thirteen woredas were affected by droughts, of which six severely (Veen, 2002). The Kalu Woreda is not only one of drought prone and food insecure woredas, but it is the second affected Woreda with an estimated population of 250,000. Table 3.3 shows the amount of food aid demand and the number of beneficiaries of the food aid given to the people in the Kalu Woreda from 2000-2004.

Table 3.3 The number of food aid beneficiaries and amount of food aid given in the Kalu Woreda (2000-04)

Year	Number of people who got food aid	Food aid given in Quintal
2000	55953	41964.75
2001	69058	51801
2002	50100	73756
2003	106775	153756
2004	38513	13852.648
Total	320399	335103.397

Source: Annual Report of Woreda Agriculture and Rural Development Office (2004)

Between 2000 and 2004, the number of beneficiaries and the amount of food aid had shown continuous and rapid increase throughout the Woreda. As it is indicated in Table 3.3, the number of food –assisted people in the Woreda was higher in the year 2003 than the other fiscal years. To minimize the problems of food insecurity, to extricate food aid beneficiaries from dependency on overseas aid and to improve the living standard of the people, great effort should be done by the government, and particularly by the peasant farmers themselves.

CHAPTER FOUR

4.0. DEMOGRAPHIC & PRODUCTION CHARACTERISTICS OF THE SAMPLE HOUSE HOLDES

4.1 Demographic Characteristics

As it is shown in Table 4.1, 88 % of the sample HHs were male headed while the remaining were headed by females. The low percentage of FHHs was the reflection of the lower proportion of FHHs who were included in the rainwater harvesting scheme of the study Woreda.

Table 4.1 Age and Sex Composition of the sample Household Heads.

Age Groups	Sex		
	Female	Male	Total
≤ 25 years	2	7	9
26-40	4	45	49
41-60	3	15	18
≥61	-	4	4
Total	9	71	80

Source: Field survey, March 2005.

The majority (61.2%) of the sample HHs who have participated in RWH scheme were young adults and ranging in age from 26 to 40 years old. Encouraging more young adults to be members of the RWH scheme may have two pronounced advantages. There is a common understanding that such young adult farmers can easily accept implementation of the new agricultural technology. In addition, since most farmers have only small farming grounds, availing RWH technology would help them to efficiently utilize their small land holdings.

62.5 percent of the households on average had family size ranging from 5 to7 members. This figure is far from the average family size of the study Woreda. While the remaining 25 and 12.5 percent house holds have from 1-4 and 8-10 family sizes respectively (Table 4.2).

Table 4.2.Family size of the sample households of

Family size	No. of Households	Percent of Total
1-4	20	25
5-7	50	62.5
8-10	10	12.5
Total	80	100

Source: Field survey, March 2005.

Almost around 50 percent of the sample households can read and write. This would be helpful to provide training and reading materials that can enhance their skill to maximize the utilization of RWH structures among the community. However, 47 percent of the respondents were illiterate.

Table 4.3 Educational background of the sample Respondents

Educational status	No. of respondents	Percent of Total
Illiterate	38	47.5
Read only	14	17.5
Read and write	20	25
Elementary	8	10
Total	80	100

Source: Field Survey, March 2005.

4.2 Land holding Size and Patterns

Land is an important natural resource and almost all peasant households in the study area depend on agriculture as a source of their livelihoods. Many households in Kalu Woreda obtained their current holdings during the 1974 land reform, which considered family size to determine the size of land allocation to households.

The 1997 'land readjustment' program, was implemented in all Kebeles of the Woreda. The official intent of the 1997 land readjustment was to make land available for the landless that comprised of basically young farmers and returnees from resettlement areas. During such land readjustment period the then landless were given two to three "timad" of land regardless of whatever family size they had.

However, there is a significant difference in landholding size among respondents in the Woreda. Most (73.8 percent) households have landholding size of greater than 3 ha and about 18.7 percent own from 2 to 3 ha of land. Only 1.3 percent of the sample farm households own less than 1.5 ha of land.

Table 4. 4.: Landholding size of Farm Respondents

Landholding size (ha)	No. of respondents	Total Percent
≤ 1.5	1	1.3
1.5-2	3	3.8
2-3	15	18.8
3-5	59	73.8
> 5	2	2.3
Total	80	100

Source: Field Survey, March 2005.

As it was expressed by key informants and identified by focus group discussions, land fragmentation is common in the study area. Fragmented landholdings have variation in their soil fertility and moisture retaining capacity for drought season. It was confirmed by key informants and group discussion many households had fragmented plots in three different areas and these fragmented farming grounds are locally named as "Eshet" farm which are commonly located near their villages, "Dega" and "Kola" farms which are far away from the village location of farmers.

However, most literature argued that fragmentation could contribute negatively for increasing production and for effective land management practices. Moreover, fragmentation is taken as hindrance for the use of modern farm inputs, and economical use of labor and time.

4.3. Land Degradation in the Study Area

Land degradation is a major problem in the Kalu wereda. It is caused by man made and natural processes and has a wide range of effects on the livelihood of rural people whose economic base is on agriculture. The major human forces that cause land degradation are induced by high population pressure which includes deforestation, overgrazing, poor farming practices and expansion of agricultural land into fragile areas. Such practice is exposing soils for water and wind erosion and consequently resulting in reduction of agricultural yields. Moreover, expansion of crop cultivation and animal grazing into sloppy and marginal agricultural and grazing areas exposes land for further degradation through erosion. Accordingly, the major causes of land degradation in the Kalu Woreda are lack of soil erosion control and poor farming practices.

Table 4.5: Farmers' views on the extent of land degradation and decline of land productivity

A. Extent of Land Degradation	No. of respondents	Total Percent
Very severe	59	73.75
Severe	9	11.25
Minor	7	8.75
Can not tell	4	5.00
No problem	1	1.25
Total	80	100
B. Decline of Land Productivity		
Very severe	35	43.75
Severe	30	37.50
Minor	7	8.75
Can not tell	5	6.25
No problem	3	3.75
Total	80	100

Source: Field survey, March 2005.

As shown in (Table 4.5) 73.7 percent of respondents considered that land degradation in the study area was very severe. 11.3 percent said that the extent of land degradation was severe. While 8.8 percent replied that the problems of land degradation was minor. Besides, 43.8 percent stated that the decline of land productivity was very severe, while 37.5 percent considered land productivity to be severe. Those who said the decline of productivity is minor accounted 8.8 percent of the respondents.

4.4. Livelihood Source of the Sample households

According to CARE (1998), livelihood activity is used to denote the range and combination of activities and choices that people undertake in order to achieve their sources of livelihood. Agriculture mainly, crop production is the major source of livelihood to the significant proportions of the sample households.

4.4.1 Crop Production

In the study area, crop production is the major source of income to farm households. The main crops cultivated are sorghum, millet, 'Teff', maize and barely in the Wodajo, Abecho and Abahlime kebels. In the Bosena Kebele. 'Teff', barely, wheat and beans are cultivated as major crops. In addition to these crops 'Dagusa' is cultivated in the low lands of Abahilme, Abecho and Wadajo kebeles. Furthermore, onions are the other 'Meher' vegetables cultivated in smaller quantities in all four Kebeles of the study area.

Table 4.6:Total crop production of the sample households in quintal/ha in 'meher' season (2003/2004).

Types of crop production	Abahlime (23 HHs)	Abecho (15 HHs)	Bosena (12 HHs)	Wodajo (30 HHs)
	Quintal	Quintal	Quintal	Quintal
'Teff'	30	21	20	39
Barely	5	3	12	5
Wheat	-	4	6	6
Oats	-	-	4	-
'Dagusa'	4	2	-	4
Maize	10	7	-	12
Sorghum/millet	62	41	-	81
Beans	-	2	4	-
Potatoes	3	-	4	-
Onions	2	3	3	3
Total	116	83	55	150

Source: Field survey, March 2005.

Of the total crop production, sorghum/millet and 'teff' account the largest share of the total annual crop production of the sample farm households in Wodajo (68 percent and 33 percent), Abahilme (53 percent and 26 percent) and Abecho (49 percent and 25 percent) Kebeles respectively. While, in order of their importance, 'Teff' and barely are the most important crop production (47 percent and 15 percent) in Bosena. The farm households produce various types of crops in the locality as a source of livelihood.

As it was confirmed from key informants during the survey, the productivity of the various types of crops varies among the Kebeels. Generally, it was highest in Wadajo and lowest in Bosena. The reasons given by the farm households were the shrinking of available crop land, land degradation, chronic shortage of water and traditional agricultural practices. Crop production and productivity vary between the crops and across the status of farm households in general, the traditional farming practices that have greatly affected the sustainability of crop production and productivity coupled with the erratic and inadequate rainfall has made the Kalu Woreda's rural farm households more vulnerable and food insecure. From group discussions, key informants and reports of development agents, it was understood that though farmers have adequate knowledge of the benefits of inputs application, they are constrained by continuous lack of rains and shortage of land. The other livelihood source of the local people is off-farm activities which include income obtained from local environmental resources such as the production of firewood, charcoal, building materials, etc.

4.5 Perceived causes, problem and solutions of Food Insecurity

According to FAO (1997), household food insecurity is a situation of inadequate food either due to food shortage or inappropriate consumption behavior or intra-household disruption. Thus, the basic cause of food insecurity is lack of access as well as supply problem and any crises that adversely affect livelihood of the family result in household food insecurity.

As it was confirmed by key informants and focus group discussion, food security is dependent on food availability. However, food availability of farm households is affected by household food production, purchasing power, and other food sources and entitlement.

As noted from the responses of sample farm households, people in the Kalu Woreda faced problem of food insecurity in 1984/85, 1987/88 and 1990/91. Out of the total sample population 83 percent of the sample households stated the existence of food insecurity problem in the study area (Table 4.7).

Table 4.7 Perceived causes, problem and solutions of food insecurity

A. Is food insecurity a problem in your household?	No. of respondents	Total Percent
Yes	66	82.5
No	14	17.5
Total	80	100
B. Perceived Causes of food insecurity		
Land degradation	10	12.5
Increased Population	2	2.5
Dependency on traditional agriculture	14	17.5
Combination of the above	40	50
Lack of food supply	14	17.5
Total	80	100
C. Perceived solutions to food insecurity		
Changing cropping pattern	16	24.2
Purchasing power& reducing consumption	5	7.6
Intensify other income generating activities	10	15.2
Grain aid and money support	2	3
Sale of small animal	8	12.1
Combination of the above	25	37.9
Total	66	100

Source: Field survey, March 2005.

The major causes of food insecurity mentioned by the respondents were dependency on agriculture (18 percent of respondents), land degradation (13 percent of respondents) and increased population pressure (2.5 percent of respondents). On the other hand, the rest of the farm households (3 percent) replied that there was no food insecurity problem in their locality.

The solutions to cope up with food insecurity problems were in order of their importance: changing cropping pattern (24 percent); intensifying other income generating activities (15 percent); sale of small animals (12 percent) and in general combinations of different mechanisms (38 percent). While a few of the respondents that accounted for 7.5 percent and 2.5 percent agreed that purchase of food and reducing consumptions, and borrowing money support and grain aid could be alternative solutions to reduce the problem of food insecurity.

Table 4.8: Households Food insecurity Versus Family Size.

Family size	Number of HHs Facing food insecurity	
	Yes	No
Less than 3	-	3
3-4	10	7
5-7	30	10
8-10	16	4
Total	56	24

Source: Field survey, March 2005.

As can be seen in Table 4.8, the comparison of household sizes against problems of food insecurity indicates that households with less than 3 household members have not faced the problem of food insecurity in the past two years. However, it appears that households with larger family sizes were more likely affected by the problem of food insecurity.

CHAPTER FIVE

5.0. IMPLEMENTATION AND UTILIZATION OF RWH SCHEME IN KALU WEREDA

5.1. The Implementation of Rainwater Harvesting Scheme (RWHS)

In Kalu Woreda, there were four types of RWH structure; dome-shaped, hemispherical, cylindrical concrete and plastic-lined structures that have been used to improve the supply of water for agricultural activities. There were 1155 RWH structures in the Woreda (Table 5.1). Of these, 808 structures were found in the four Kebeles under which the study has been conducted.

Table 5.1 Types and Number of RWH Structures Constructed in Kalu Woreda from 2001-2004.

Year	Types of RWH Structure				
	dome-shape	hemispherical	Plastic- lined	Cylindrical	Total
2001	2	-	-	-	2
2002	15	57	-	-	72
2003	6	49	902	-	957
2004	1	1	121	1	124
Grand Total	24	107	1023	1	1155

Source: Annual Report of Kalu Woreda Agriculture and Rural Development Office (2004).

As shown in Table 5.1, the number of RWH structures constructed in the Woreda was only 2 in 2001. However, in 2004 it grew to 1155 ponds. The construction of plastic-lined ponds was increased to 1023 within two years period (2003-2004). There were 107 hemispherical ponds from 2002 to 2004 while there were only one cylindrical ponds in the study area.

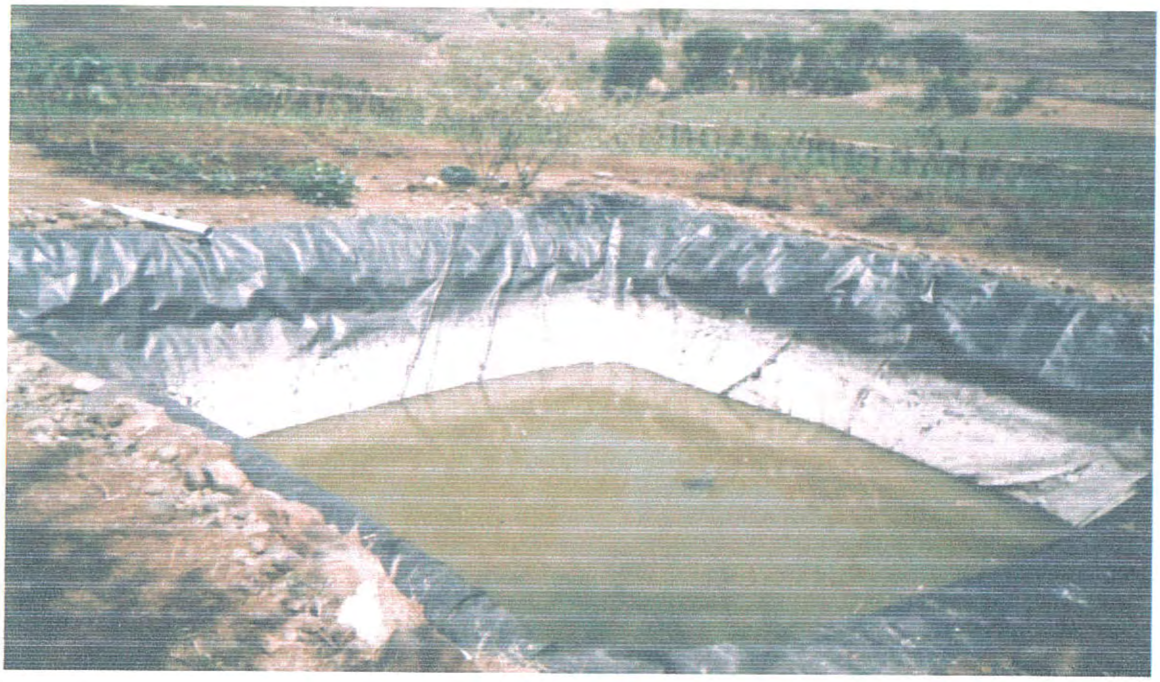
In addition, there were two river diversions at Cheleka and Tigo rivers. The Cheleka river diversion was constructed both by the Woreda Administration and an NGO named Concern Ethiopia. The Woreda Government had constructed the upper stream irrigation development of the Cheleka River that was planned to irrigate 20-30 ha of land and support 49 farm households. But only 5 ha of the planned were irrigated only by 15 households during the field work in 2005.

Similarly, the Concern Ethiopia had started an irrigation work at the lower stream of the Cheleka River which covers a total irrigable area of 40 ha that had been estimated to serve 69 farm households. From these, 25 ha were irrigated by 39 households in 2005.

Picture 5.1: Dome shaped RWH Structure in Abecho Kebele, March 2005

Picture 5.2: Hemispherical RWH Structure in Bosena Kebele, March 2005

Picture 5.3: Plastic lined RWH structure in Wodajo Kebele, March 2005.



Picture 5.4. Cylindrical Structure in Abahilme Kebele, March,2005

5.1.1 The Processes in Implementation of RWH Schemes

In the Amhara Region, RWH was mainly implemented in food-insecure Woredas through the food-for-work program and employment generation schemes (EGS).The Woreda Agriculture and Rural Development Office is responsible for undertaking many aspects of the implementation processes in providing technical assistance in the construction the RWH structures in a better condition. The same office is also responsible to supervise the execution of RWH schemes at Woreda levels. Some of the activities include the provision of different seeds and seedlings, creating awareness in protecting and conserving soil, etc.

The implementation of the water harvesting scheme was the responsibility of the Woreda Agriculture and Rural Development Office. In the last fiscal years, ponds and tanks were implemented free of charge for the beneficiaries, who only had to contribute their own labour, usually paid by food-for- work or through Employment Generation Schemes (EGS). However, in the Woreda during the initial year the imposed quota structures of RWH were constructed under pressure.

Table 5.2 Planned and Constructed RWH structures in Kalu Woreda (2004/05)

Types of Structures	Planned	Constructed	Difference	Percent of Constructed Vs Planned
Dome-shaped, Cement	85	24	61	28.2
Hemispherical, cement	250	107	143	42.8
Plastic-lined	1650	1023	627	62
Cylindrical shaped, cement	10	1	9	10
Micro Ponds	12110	10184	1926	84
Total	14105	11339	2766	80.4

Source: Annual Report of Kalu Woreda Agriculture and Rural Development Office (2004/05).

Table 5.2 shows the planned and constructed RWH structures of the study Wereda. The plan for construction of micro ponds had failed by 1926 in number which accounted 16 percent of the total plan in 2004/05. Similarly, the plans for plastic-lined and hemispherical structures showed a difference of 627 and 143 structures respectively compared to what was achieved. In general, 2766 structures had failed from all types of structures that were planned to be constructed in the Wereda in 2004/05.

Table 5.3 The Distribution of RWH Structures in the four kebeles in the study Woreda, 2004.

Kebele	Type of Structures				
Administration	dome-shape	hemispherical	Plastic- lined	Cylindrical	Total
Bosena (09)	1	4	86	-	91
Abahilme (018)	1	9	286	1	297
Abecho (019)	4	21	102	-	127
Wodajo (022)	4	17	272	-	293
Grand Total	10	51	746	1 '	808

Source: Annual Report of Kalu Woreda Agriculture and Rural Development Office (2004).

As indicated in the above table, out of 1155 RWH structures in the Woreda, 808 were found in the study Kebeles. Because almost two third of the area of these Kebeles are found in the low lands, which has been suffering from frequent drought. From the total of 808 structures, 746 (92%) of the total ponds were plastic-lined. Among the types of RWH structures of the study area, plastic-lined ponds were given more emphasis because of the availability of plastic materials, and the more simplicity of its work and cost than other s tructures. A gain, from t he f our K ebeles, 38 p ercent o f p lastic-lined p onds w ere constructed only in Abahilme Kebele.

5.1.2 The Utilization of Harvested Rainwater

As it is shown in Table 5.4, collected water in the RWH structures have been used for the cultivation of vegetable, livestock and home consumption, etc. Hence, the majority of the respondents have used the RWH mostly for vegetable production and the combination of different purposes.

Table 5.4 Types of Water use from the RWH structures and Extent of contribution to Food Security

A. Types of use	No. of Respondents	Percent
Home consumption	3	7.5
Livestock watering	3	7.5
Vegetable production	20	50
Combination different purposes	14	35
Total	40	100
B. Extent of contribution to food security		
High	27	67.5
Low	13	32.5
Total	40	100

Source: Field Survey, March 2005.

With regard to the extent of contribution of RWH to household food security, 67.5 percent of the respondents provided high rate to the contribution of RWH in maximizing the food security of the community while 32.5 percent rated the contribution of RWH to be low.

Table 5.5 Involvement of beneficiaries in the implementation of RWH Scheme.

Involvement of respondents in RWH Scheme	Number of Respondents	Total Percent
Willingly	34	85
Coerced	6	15
Total	40	100

Source: Field Survey, March 2005.

Out of the 40 beneficiaries who were included in the program, 85 percent indicated their integration into the program on voluntary bases. However, 15 percent stated that they were engaged in the program without their willingness.

5.2. The Constraints of RWH Program

According to the evidence obtained from focus group discussion, interview results of key informants and development agents, the performance and effectiveness of the RWH program was constrained through a number of problems. Some of the major challenges were:

1. ***The wider Implementation of RWH scheme within a short period***: The wider practicing of the RWH within a short period of time might be one of the different challenges of the program.

2. ***Professional and Technical Weakness:*** It leads to the flaws in the design and cracks in RWH structures. For instance in one site Abecho kebele, the researcher has observed that some hemispherical tanks did not have collected water. Because the structure has been constructed on cotton black soil that can crack during the dry season (picture 5.5). The tanks bore numerous wide cracks at different levels on the walls. Some framers in Bosena and Wadajo Kebeles had tried to patch the cracks with cement, but the farmers did not maintain the cracks. The cracks reappear shortly after re-patching. A farmer in Bosena Kebele complained the money and labour of his family wasted in repairing the cracks of RWH structures.

3. ***Risk Exposure:*** Children and animals fall into RWH ponds since all the structures were not fenced.

4. ***Pollution of collected water:*** the RWH structures are favorable for the growth of green plants(Algea). During the dry season, when the amount of water dwindles, the layer and thickness of the remains of green plants form a continuous accumulation on the beds of structures. So, this result in a bad smell of water collected in the ponds (Picture 5.6).

5. **The coldness of the water in the RWH**: Water particularly in the dome ponds damage vegetables and fruits when these plants are watered close to their roots.

6. **The spread of mosquitoes:** The water collected in the RWH structures favour the spreading of mosquitoes that causes malaria.

Picture 5.5: Cracks in the RWH Structure in Abahilme Kebele, March 2005

Picture 5.6: Accumulation of Plant remains in the Upper surface of the RWH Structure in Abecho kebele, March 2005.

Table 5.6: The Opinion of sample Households about Sufficiency of the harvested water for various Purposes.

A) Is the availability of water in the RWH ponds sufficient?	No. of Respondents	Percent of Total
Yes	26	65
No	14	35
Total	40	100

As revealed in Table 5.5, 65 percent of respondents get the access of sufficient water supply from RWHS for planting different types of vegetables and fruits around the ponds. However, 35 percent disagreed about the sufficiency of water in the RWH structures.

Table 5.7: Problems in the Construction of RWH structures of Water in RWH schemes

A. Are there constraints in the construction of ponds?	No. of Respondents	Percent of Total
Yes	12	30
No	28	70
Total	40	100

Source: Field Survey, March, 2005.

Shortages of materials, technical assistance, working interaction, etc are some of the major constraints of challenging the construction of RWH structures though 70 percent argued as there were no problems, while 30 percent believed in the existence of constraints starting from the very beginning of digging to the completion of the construction.

5.2.1 Attitudes of Non-beneficiaries towards RWH program

80 percent of the respondents replied as they never lost any opportunity from RWH Scheme while 20 percent believed that they missed opportunities being outside the RWH program (Table 5.8). 57.5 percent of the respondents were not interested to accept the RWH program. The remaining 42.5 percent of the non-beneficiary sample households were willing to be involved in the RWH program on their personal willingness.

Table 5.8 Views of Non-beneficiaries on RWH program

A. Do you feel that you missed opportunities from RWH program so far?	No. of Respondents	Total Percent
Yes	8	20
No	32	80
Total	40	100
B. Would you like to implement RWH for yourself?		
Yes	17	42.5
No	23	57.5
Total	40	100

Source: Field survey, March 2005.

5.2.2. Potentials of RWH to Contribute to Food Security

22.5 percent of the non-beneficiaries stated that RWH can contribute to food security (Table 5.9). The RWH schemes served as a source of water for the production of vegetable, fruits, etc and hence raise the additional income of farmers. However, 77.5 percent of the non-beneficiaries argued that RWH would have no contribution to the improvement of food security.

Table 5.9 Views of Non-beneficiaries on RWH contribution to food security

Can RWH contribute to food security?	No. of households	Percent of total
Yes	9	22.5
No	31	77.5
Total	40	

Source: Field Survey, March 2005.

CHAPTER SIX

6.0. SUMMERY OF MAJOR FINDINGS AND RECOMMENDATIONS

6.1. Summary of Major Findings

In Ethiopia, food insecurity is seen as the most important feature of development challenges. Every year, particularly in the rural areas, more than four million people lack the supply of enough food. Hence, such people require external assistance. The frequent occurrence of food shortage is the result of a combination of different factors. Adverse climatic conditions such as droughts combined with high human population pressure and environmental degradation have led to the decline in land holding size of households and agricultural productivity per hectare (Tassew and Eberlei, 2004).

Rainwater harvesting program has been launched as one of core strategies for improving food security, especially in drought-prone woredas of Ethiopia. Of such Woredas in Amhara Region, Kalu is one of the most drought-prone and food insecure. It has, since the past few decades, been severely affected by drought and unreliable rainfall, both of which resulted in food shortage and abject poverty to the people.

The major purpose of the study was to assess the perception of peasant households about the potentials of RWH to contribute to food security in the Kalu Woreda, South Wollo Zone, Amhara National Regional State. An attempt has been made to document the attitudes of the study population towards RWH program. The number and types of structures of ponds constructed at four sample Kebeles in the woreda as well as the implementation problems of the program were also examined in the study.

Both quantitative and qualitative approaches have been employed. Sample households were selected through stratified random sampling technique. A total of 80 households drawn from users and non-users of RWH were selected for the study. Household survey, key informant interview and focus group discussion were conducted for gathering the required data. The major findings of the study are the following:

- The study Woreda's plan for RWH construction was assessed against its actual performance, and in the year 2004/05 about 80 percent of the plan has been accomplished.

- An examination of the distribution of constructed RWH structures indicated that about 70 percent of the structures in the Kalu Worda were found in four sample Kebeles while the remaining 30 percent were sparsely distributed in 31 Peasant Associations (Kebeles).

- The poor quality in the construction of RWH led to the cracking of structures and the problem of safety which is a threat to children and animals were identified as the major challenges that strictly hinder the potential usefulness of the program.

- The continuous pressure from the Regional government up on the Woreda administration to implement its quota did coerce the community to involve in the RWH program in the initial phase.

- As the survey result indicated 58 percent of the non-beneficiaries replied as they have lost agricultural opportunities being out of the RWH program and most respondents did not have any interest to participate in RWH sceme in the future.

6.2 Recommendations

Based on the major findings, the following recommendations have been forwarded:

- Emphasis was given by the Worda government to construct a large number of RWH structures to alleviate the problem of food insecurity. But the implementation processes had been bounded by several challenges. Such problems can be minimized through:

  - Reducing the flaws in the design of structures and the easing pressure on the quota system. This can help the Woreda administration to plan in line with its implementation capacity and take time to construct quality structures. It is advisable and important to design an appropriate RWH plan that coincides with the implementation capacity of the Woreda government and the kebele administrations.

  - RWH structures should be placed at right and proper place so that they collect and hold maximum runoff from rain.

  - A thorough analysis and selection should be made to tailor the most appropriate technological structure of RWH scheme to the specific agro-ecological areas.

  - Advising and supporting peasant households to make strong fence for hemispherical and plastic lined structures that can be locked with a gate, and to cover the ponds with relatively cheap and available local materials to reduce the threats to children and animals as well as to minimize the extent of evaporation from the ponds are crucial.

- Effective achievement of the objectives of the RWH program requires active and voluntary participation of the local community or beneficiaries.

- Since the large majority (77.5%) of the non-beneficiaries have not felt the practical importance of RWH for improving food security at household level, timely reassessment is important to identify specific problems and make the program implementation congruent with the needs and aspirations of the rural community. Appropriate RWH programs should involve experiences from traditional techniques, and should also be expanded based on lessons learned from the shortcoming of previous programs.

- In order to strengthen the know–how of the rural community about RWH technology as well as minimize the reluctance of the rural people, it is advisable to begin any future RWH activities at a pilot scale within specific demonstration sites.

- Efforts should be made to raise awareness and interest of households about the potential opportunities, and multidimensional uses of RWH to the rural people whose primary activity is based on agriculture. This should be the primary function of the Woreda administration, professionals and development agents to enable the community to realize the best use of RWH.

- In alleviating the problem of food insecurity in the woreda; however, emphasis should also be given to:-

- The promotion of supplementary employment and income generating schemes through skill development training on modern animal genetic breeding; better use of pastureland and other fodder products.

- Enhancing agricultural production by enhancing rural credit service in order to enable the peasant households to utilize inputs such as compost and fertilizers, improved seeds in their farms, and to expand other micro business of income generating activities such as off-farm and non-farm activities that are valuable to the community.

BIBLIOGRAPHY

Agarwal, A. and Narain, S.(1997). Making water everybody's Business: Practice and policy of water harvesting. Center for Science and Environment (CSE), India.

Alamerew, E.B.(2001). Overview of rainwater harvesting for crop production in Ethiopia in: Wanyonyi, J.M.,S. Ngigi, P.Mwangi and D. Onyango (eds.), 2001. Proc. Of GHARP Strategic Planning and project Implementation planning Workshops. GHARP publication No.1. Nairobi, Kenya.

Allen, T. and Thomas, A. (1992). Poverty and Development in the 1990s. Oxford Universikty Press.

Asante, S.K.B. (1986). Food as a focus of national and regional policies in contemporary Africa. In: Hansen, A and D.E. McMillan D.E (eds.). 1986. Food in Sub-Saharan Africa. Rynne Rienner Boulder, Colorado, USA. 11-24

Barrow, C.J. (1987). Water resources and agricultural development in the tropics Longman Group UK Ltd., Essex, UK.

Barton, D. Morton J., and Heady C. (2000). "Paternalists and drought contingency planning: Overview and Recommendation." In Morton J. (ed) Paternalism, drought and planning: lessons from Northern Kenya and elsewhere. Chatham, UK Natural Resource Institute.

Ben-Asher ,J. and P.R. Berliner. (1994). Rnoff irrigation. In. Tanji, K.K. and B. Yaron (eds). Advances in agricultural sciences. Vol. 22. Berlin, Springer Verlog. 127-154.

Bores, T.M. and Ben-Asher, J. (1982). A review of rainwater harvesting. In: Agricultural Water Management 5:145-158.

Bruins,H.J.,Evenari, M.and Nessler, U.(1986). Rainwater-harvesting agriculture for food production in arid zones: the challenges of African famine. Applied Geography 6:13-32.

CARE (1998). Initial Environmental E xamination – C ARE E thiopia D AP F ood and Livestock Security Program
Addis Ababa: CARE – Ethiopia, March 1998.

CRDA (1998). Training program on Food Security and vulnerability Assessment . 16-25 September, 1998, Awassa.

Critchley, W.and K. Siegert. (1991). Water harvesting: A manual for the design and construction of water harvesting schemes for plant production. FAO, AGL/ MISC/ 17/91. http://www.fao.org/docrep/ U3160E00.htm

Critchley, W. (1997. Some lessons from water harvesting in Sub-Saharan Africa. Report f rom a w orkshop h eld i n B aringo, K enya o n 1 3-17 O ctober, 1986. The World Bank Eastern and Southern Africa Projects Department. P 58

Cullis, A. and A. Pacey. 1992. A development dialogues: Rainwater harvesting in Turkana. Intermediate Technology, London, UK. P. 126

Dagnew Eshete (1993) . The Impact of Food shortages on Rural Households of Different Income Groups and Their Crisis Coping Strategies: A Case Study of Walaita District in Ethiopia. Ph.D. Thesis, Sussex University,Brighton.

_______________(1994). Food Shortage and Household Coping Strategies by an Income Groups: A Case Study of Wolaita District in Southern Ethiopia. Paper presented to the fourth annual conference on the Ethiopian Economy, Addis Ababa, December 1994.

_______________(2000).The Role and Contributions of Non-Government Organization (NGOs) in Food Security in Ethiopia.

Day, Robert A. (1994). How to write and publish a scientific paper. London: British Council.

Debebe Habtewold (2001). Food Aid and Its Impacts on Peasant Livelihood Strategies, Forum for Social Studies, Addis Ababa, 2001.

Duckham, A.N. and G.B. Masefield. (1985). Farming Systems of the world. Praeger Publishers, New York, USA.

Encyclopedia Britannica. (1997). 15th, ed., Vol. 4, 1997

EEA (1999/2000). Annual Report on the Ethiopian Economy. 2nd ed.Vol. 1. Ethiopia, Addis Ababa.

ECA (1997). Africa Water Vision 2025, Addis Ababa, Ethiopia.

Evenari, M., Shanan, L. and Tadmor, N. H.(1971). The Negev, the challenge of a desert. Harvard University Press, Cambridge, Mass.

FAO (1994). Water Harvesting for Improved Agricultural Production. Rome: FAO UN.

______ (2002). Agriculture: Towards 2015/2030. Technical interim report, Economic and social Department. http//www.fao.org/es/esd/at2015/toc-e.ttm, FAO, Rome.

Fattovich, Rodolfo (1990). Remarks on the Pre-Axumite Period in Northern Ethiopia. Journal of Ethiopian Studies. Vol. 23:1-33.

Gabre Emanuel Teka (1997). Water Supply – Ethiopia: An Introduction to Environmental Health Practice. Addis Ababa: A.A.U. Press.

Getachew Alem (1999). Rainwater Harvesting in Ethiopia: An overview. 25th WEDC conference, Addis Ababa, Ethiopia.

Gezahegn Ayele, Omamo, W.Steven and Eleni Gebremedhin (2003). The State of Food Security and Agricultural Marketing in Ethiopia. Addis Ababa. The Ethiopian, Development Research Institute.

Gould, J. and E.N. Petersen. (1999). Rainwater catchments systems for domestic supply: Design, construction and implementation. It Publications Ltd., London, UK.

Hatibu, N. and H.F. Mahoo (eds.). (2000) Rainwater harvesting for natural resources management: A planning guide for Tanzania. Technical Handbook No. 22. RELMA, Nairobi.

Hubbard, M.(1995). Improving Food Security: A guide for Managers. Intermediate Technology Publications, UK.

Hunt-Davis Jr. (1986. Agriculture, food, and the colonial period. In: Hansen, A. and D.E. McMillan (eds.). 1986. Food in Sub-Saharan Africa. Rynne Rienner, Boulder, Colorado, USA. 151-168

Hurini. H 1986. Guidelines for development agents on soil conservation in Ethiopia community Forestry and Soil Conservation Development Department (CFSDD), Ministry of Agriculture, Addis Ababa, Ethiopia.

Hyden, G. (1986). The hidden economy of the smallholder agriculture in Africa. In: Moock, L. 1986. Understanding Africa's rural household and farming systems. Westview Press, London, UK.

International Fund for Agricultural Development (IFAD) (1992)."The State of World Rural Poverty:IFAD'S Evolving Experience, a Technical Paper," Rome.

ILRI (2002). Food Security in Sub-Saharan Africa to 2020: Socio-Economic and policy Research Working Paper 49, Nairobi, Kenya.

Isika, M.,G.C.M. Mutiso and M. Muyanga. (2002). Kitui sand dams and food security. MVUA GHARP Newsletter. Vol. 4. April 2002 Edition. Kenya Rain water Association, Nairobi.

IWMI (2003). Integrated Livelihood and Natural Resources (water and land) Management. Position Paper Contributed to the Proposal Formulation Workshop of the Sub-Saharan Africa Challenges Program, Accra, Ghana.

_______ (2000). Water supply and demand in 2025. International Water Management Institute (IWMI), Colombo, Sri Lanka.

Jodha, N.S. and A.C. Mascarenhas. (1985). Adjustment in self-provisioning societies. SCOPE 27. John Wiley and Sons, New York, USA

Kiggundu, N. (2000). Evaluation of rainwater harvesting systems Rakai and Mbarara Districts, Uganda. GHARP case study report. Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association, Nairobi, Kenya.

Kihara, F.I. (2002). Evaluation of rainwater harvesting systems in Laikipia District,, Kenya. GHARP case study report. Greater Horn of Africa

Rainwater Partnership (GHARP), Kenya Rainwater Association, Nairobi, Kenya.

Kutch, H. (1982). Principle features of a form of water concentrating culture. Trier Geographical Studies No. 5. Trier, Germany.

Lameck, P.G.M. (2001). Evaluation of rain water harvesting systems in Dodoma District, Tanzania. GHARP CASE STUDY REPORT. Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association, Nairobi, Kenya.

LEISA. (1998)., Challenging water scarcity. ILEIA Newsletter for the Low External Input and Sustainable Agriculture. 14(1). Editorial.

Lemachand, R. (1986). The political economy of food issues. In: Hansen A. and D.E. McMillan (eds). 1986. food in Sub-Saharan Africa. Rynne Rienner, Boulder, Colorado, USA. 25-42

Lundgren, L. (1993). Twenty years of soil conservation in Eastern Africa. Regional Soil Conservation Unit (RSCU) Report No. 9, Majestic Printing Works, Nairobi, Kenya. P 47

Markos Ezra (1997). Demographic Responses to Ecological Degradation and Food Insecurity: Drought Prone Areas in Northern Ethiopia. Amsterdam: PDOD Publication Series (A doctoral Dissertation).

Maxwell, S.(1992). Food Security in Africa: Priorities for Reducing Hunger, in: Africa Recovery, No 6:1-12.

Matlock, W.G. and Dutt, G. R. (1986). A Primer on water harvesting and runoff farming Agricultural Engineering Department /University of Arizona, USA.

McLoughlin, P.F.M. (1970). African food production systems. The John Hopkins Press, Baltimore and London, UK.

Mesfin Wolde Mariam (1985). "The Socio economic Consequences of Famine," In Fassil, G.K(ed) Challenge of Rural Poverty. New Jersey: World Press, PP.11-19.

MOA (2001). Soil and water conservation report . Kitui Agricultural Office, Kitui, Kenya.

MOE (2000). Geography, Addis Ababa: Mega Publishing Agency.

MoWRD. (2000). Ethiopian Water Resources Management Policy, Ministry of Water Resources Development (MoWRD), Addis Ababa, Ethiopia.

Mulat Demeke, et al. (1995). Food Security, Nutrition and poverty Alleviation in Ethiopia: Problems and Prospects, Agricultural Economics of Ethiopia, Addis Ababa,

Nega, H. and P.M. Kimeu. (2002). Low-cost methods of rainwater storage: Results from field trials in Ethiopia and Kenya. Technical Report No. 28. RELMA, Nairobi, Kenya.

Ngigi, S. N. (2002a). Hydrologi8cal impacts of up-scaling rainwater harvesting on Ewaso Ng'iro river basin water management. Ph.D. proposal submitted to IHE, Delft, The Netherlands

Ngure, K.N. (2002). Evaluation of rainwater harvesting systems in Kitui District, Kenya. GHARP case study report, Greater Horn of Africa Rainwater Partnership (GHARP), Kenya Rainwater Association, Nairobi, Kenya.

Oweis,T., A. Hachum and J. kijne. (1999). Water harvesting and supplemental irrigation for improved water use efficiency. SWIM Paper No. 7. IWMI, Colombo, Sri Lanka. P 41

Pacey, A. and A. cullis. (1986). Rainwater harvesting: the collection of rainfall and runoff in rural areas. IT Publications, SRP, Exeter. London, UK.

Parr, J.F., B.A. Stewart, S.B. Hornick and R.P.Singh. (1990). Improving the sustainability of dry land farming systems: P A global perspective. In: Singh, R.P., J.F. Parr and B.A. Stewart (eds.). Advances in soil science, Vol. 13: 1-8. Dry land agriculture strategies for sustainability. New York, UISA.

Patrick, E. (1997). Assessing water harvesting suitability. In: Hudson, N.W. (ed.). Soil and water conservation in semi-arid areas. FAO Land and Water Development Division. Water Report 16. http:d/ /www.fao.org/docrep/W7320B/w7320b16.htm

Petersen, E.N. (2000). Water from sand rivers. A manual on site survey, design, construction and maintenance of seven types of water structures in riverbeds. Technical handbook No. 23. Regional Land Management Unit (RELMA). Nairobi, Kenya.

Pretty,J. and R. Hine. (2001). Reducing food poverty with sustainable agriculture. A summary of new evidence. Final report from "SAFE-World" research project. University of Essex, UK. P 133

Pwani, N.B. (2002). Personal communication. He is the Regional WatSan program officer, International Federation of Red Cross and Red Crescent Societies, Regional Delegation Nairobi, Kenya

Reij, C., I. Scoones and C. Toulin. (1996). Sustaining the soil: Indigenous soil and water conservation in Africa. EarthScan, London, UK. P 228

Reij, C, Mulder, P. and Begemann, L. (1988). Water Harvesting for Plant Production. Washington, D.C.: The World Bank.

Rockstrom, j. (2001). Green water security for the food makers of tomorrow: Windows of opportunity in drought-prone savannahs. Water Science and Technology, 43 (4): 71-78

Rockstrom, J. and M. Falkenmark.(2000). Semi-arid crop production from a hydrological Perspective: Gap Between potential and actual yields. Critical Review Plant Science, 19(4): 319-346

Rockstrom, J., a. Kitalyi and P. Mwalley. (1999). Conservation tillage and integrated land management: Field experiences and extension approaches. Paper presented at the ATNESA/SANAT International Workshop on Empowering Farmers Through Animal Traction into the 21st Century. South Africa, September 20-24, 1999.

Rosegrant, M.W. and N.D. Perez. (1995). Water resources development in Africa: A review and synthesis of issues, potentials and strategies for the future. IFPRI, Washington, DC. USA.

Sally, H., Inocencio, H. and Merry, D. (2003)."Agricultural Land and Water Management for Poverty Reduction and Economic Growth in Sub-Saharan Africa: Setting the Research Agenda." African Water Journal 10 (2): 20-29.

Savenije, H.H.G. (1999). The role of green water in food production in Sub-Saharan Africa. Article prepared for FAO. http://www.fao.org/ag/agl/aglw/webpub/greenwat.htm

Shanan, L. and N.H. Tadmor, 1976. Micro-catchment systems for arid zone development. Hebrew University of Jerusalem and Ministry of Agriculture, Rehovet, Israel

SIWI. (2001). Water harvesting for upgrading rainfed agriculture. Problem analysis and research needs. SIWI Report No. 11.Stockholm International Water Institute (SIWI), Stockholm, Sweden. P 97

Tassew Woldehanna and Eberlei, W.(2004). Pro-poor Budgeting and the Role of Parliament in the Implementation of PRSAP in Ethiopia. Addis Ababa: GTZ and Department of Economics, Addis Ababa University.

Thomas D.B. (1999). Where there is no water A story of community Water development and sand dams in Kitui district, Kenya. SASOL and MAJINA UFANISI, Nairobi, Kenya.

Thomas,D.B. (ed.). (1997). Soil and water conservation manual for Kenya . SWCB , Ministry of Agriculture, Livestock Development and Marketing. English Press, Nairobi, Kenya. P 294

Tiffen, .M and M. Mortimore (1994) .Environment, population growth and production in Kenya: A case study of Machakos district. International Institute of Environment and Development (IIED), paper No 47

Timberlake, L. (1986). Africa in crisis: The causes and the cures of environmental bankruptcy. Earthscan, London, UK.

UN OCHA –Ethiopia (2003). Ponds filled with challenges: Water harvesting-experiences in Amhara and Tigray. Addis Ababa, Ethiopia.

UN (2000). The Elimination of Food Insecurity in the Horn of Africa: A Strategy for Concerted Government and UN agency action, Final Report, 2000.

Veen, A.(2002). Report on the Food and Nutrition Situation in South Wollo, Amhara Region, Ethiopia,WHO/ORHC

World Bank (1998). Assessing Aid: What Works, What doesn't and Why, Washington D.C.

__________ .(1997) World Development Report. World Band, Washington D.C, USA.

__________ . (1992). Development and the environment. World Development Report. Washington D.C.

Yared Amare (2001). Food Security and Sustainable Livelihoods in Ethiopia: Forum for Social Studies, Addis Ababa, 10-11 March 2000.

Zewdie Abate (1994). Water Resource Development in Ethiopia: An Evolution of Present Experience and Future planning Concepts. Lebanon: Ithaca Press.

APPENDIX 1

Survey Questionnaire for Assessing the Contribution of Rainwater harvesting to food security of peasant households in South Wollo, Ethiopia

Name of enumerator ---------------------------------

Date ---

Name of respondent ---------------------------------

I. General Information

1. Zone --

2. Woreda ---

3. Agro- ecological zone----------------------------------

4. Name of Kebele Administration -------------------------

II. Questions for both Beneficiaries and Non-Beneficiaries peasant

Households of Rainwater Harvesting Scheme

A. Peasant Household Demographic and Socioeconomic Characteristics

1. Age-- ☐

2. Sex 1= Male 2= Female ☐

3. Position of the interviewee in the household

1= head 2= spouse of the head

3= household member ☐

4. Household size 1. Less than 3 2. 3-4 3. 5-7

4. 8-10 5. Greater than 10 ☐

5. Size of landholding in hectare (in any local unit)

1= less than 0.5, 2 = 0.5 – 1 ,

3= 1-1.5, 4= 1.5 –2

5= 2-3, 6 = more than 3 hectare ----- ☐

6. Educational Level of Household heads

1= Illiterate 2= Read only,

3= Read and write, 4= Elementary school

5= Junior secondary school 6= High school 7= other --------------------- ☐

7. Wealth ranking according to the local community standards of the head

1= rich, 2=medium, 3= poor, 4= very poor ☐

8. Wealth ranking indicators in the local community

1= oxen and cows, 2= corrugated iron roofed house

3= good clothes and blanket

4= mule, donkey

5= any combination of the above

6= others (specify) ------------------------ ☐

9. Socio-political status within the community

1= community elder,

2= leader or representative of religious set up,

3= Farmers cadre,

4= leadership member of the Kebele Administration

5= Others (specify) -------------------------- ☐

B. The following questions are about food security and nutrition

1. Is there food insecurity problem in your locality?

1= yes 2= No ☐

2. If yes, what would you think the cause?

1= land degradation 2= absence of credit system

3= increased population

4= dependency only on agriculture

5= others ---------------------------- ☐

3. Were there any food security activities?

1= Yes 2. No ☐

4. If yes, what intervention activities take place?

1= promoting resources (soil, water, moisture) conservation techniques

2= looking for other greater income alternatives

3= waiting for relief food aid

4= others -----------------------------------

5. Did the intervention measures bring positive achievement?

1= Yes 2 = No

6. If no, why is that so? --

7. Is there food problem?

1= Yes 2= No

8. If yes, what are the main food problems of the locality?

1= extent of more dependent population

2= household vulnerability to food /money/ land shortages

3= rural malnutrition and hunger trends

4= know how problem

5= others-- -

9. Do you participate in any food – for- work activities?

1= Yes, 2. No

10. If yes,

1= how long have you participated? ---------------------------------

2= how much do you earn? --

11. What mechanisms had been used to cope up with food security problems? /put in order of importance?

1= change cropping pattern

2= purchase food and reduce consumption

3= Intensify other income generating activities

4= borrow grain and money

5= sale of small animals live sheep and goat

6. = others............................

C. The following questions are about drought

1. Did your locality experience drought?

1= Yes 2= No

2. If yes, when did it occur?

1=---------, 2= -----, 3= ------, 4 = --------

5= --------, 6= ------,

3. At what frequency does it happen?

1= every 10 years 2= every 8 years

3= every 5 years 4= every 2 years

5= every years 6=other -----------------------------------

4. Did you receive advice / assistance how to combat drought?

1= Yes 2= No

5. If yes, was the advice useful?

1=Yes 2 = No

6. What do you do if you were warned of a forthcoming drought or famine before a year ?

1= save money to buy food

2= sell livestock to buy food

3= stay and see 4= migrate

5= stop wasting time on the far,

6= others-----------------------------

7. How much do drought and famine affect your locality? (put in order of importance)

1= not much

2= result at temporary immigration (in search of food, work)

3= permanent migration

4= increase drop out of school children

5= loss of livestock

6= loss of human life

7= others..............................

8. What did the government do to assist the people of your localityduring famine?

1= controls food prices by increase the supply of market

2= provide relief food aid

3= does nothing

4= other responses------------------ ☐

9. Do you personally agree with food rationing support of the government?

1= Yes 2 = No ☐

D. The following questions are about soil and water availability

1. Does your plots of land have problem of erosion?

1= Yes 2= No ☐

2. If yes, how do you view the level of erosion on your plots?

1= very severe, 2= sever, 3= minor,

4= can't tell ☐

3. How serious is the decline in soil productivity on you main plots with reference to normal year (adequate rainfall)?

1= very severe 2= severe, 3= minor,

4= no problem 5= can't tell ☐

4. Have you received advice on how to prevent soil erosion?

1= Yes 2 = No ☐

5. If yes, was it useful in preventing soil erosion?

1= Yes 2 = No ☐

6. Do you practice plots of land-use alternatives?

1= Yes 2 = No ☐

7. If yes, is it?

1= rain fed agriculture

2= irrigation agriculture

3= both ☐

8. If no irrigation why?

1= irrigable land scarcity

2= water problem

3= know how problem

4= others---------------------------

9. Is there water availability problem in the locality?

1=Yes 2 = No

10. If yes, what would you think the solution?

1= government water supply

2= NGOs supplementary aid for water construction

3= public participation in strengthening springs and divert rivers to irrigable lands,

4= decreasing over utilization of water

5= others (specify ------------

11. If No, what are the sources?

1= springs 2= rivers 3= lakes 4= ponds

5= rain water ---------

APPENDIX 2

III. The following questions are about Beneficiaries of the rainwater harvesting programme.

1. Are you voluntarily involved in RWH programme?

    1= Yes 2 = No ☐

2. If No, who obliged you to involve in the programme?

    1= your family 2= the community

    3= the development agents

    4= the Kebele administration

    5= others (specify) ---------------------- ☐

3. How do you consume your own reservoir?

    1= for home consumption

    2= livestock consumption'

    3= for irrigation

    4= for any combination of the above

    5= other (specify) ------------------ ☐

4. Is the availability of water in the reservoir?

    sufficient for both domestic consumption and dry season irrigation?

    1= Yes 2 = No ☐

5. If No, why not---

    ----

6. Do you think RWH programme have contribution to alleviate poverty and ensure food security?

    1=Yes 2 = No ☐

7. Is/are there a constraint in digging and constructing ponds for reservoirs?

1=Yes 2 = No ☐

8. If yes, list down in order of importance

1= ---

2= ---

3= ---

4= ---

9. Have you ever faced problems associated with the use of irrigation?

1=Yes 2 = No ☐

10. If yes, what are the major problems?

1= shortage of water

2= land size reduction

3= lower quality of a pond ☐

4= water utilization problem

11. Have you faced any problem of crop failure using irrigation in RWH?

1= Yes 2 = No ☐

12 .if yes, which of the following are the major causes?

1= water shortage 2= production decline

3= siltation 4= crop diseases

5= poor irrigation system ☐

6= any combination of the above ------

13. What options are available to you to get food items in case of crop failure?

1= food aid 2= food for work and relief

3= market 4= support from relative ☐

5= stock

14. What options are available to get cash income in case of crop failure /low production?

1= wage in locality 2= wage work in urban areas

3= remittances 4= asset sales 5= others ☐

15. Since the practice of irrigation system which of the following dietary times are experienced in your household?

1= more than 3 time 2= 3 times

3= 2 times 4= 1 time

16. Can you tell us the impact of RWH in irrigation programme on livestock? production in relation to disease occurrences, grazing land and animal feed availability?

1= better 2= worse

3= no significant impact

17. Advantages of RWH for irrigation are:

1= to expand farm size

2= to diversity crop between cash and food crops,

3= to intensify production

4= to fill rain fall gap

5=to get more food for livestock

6= all

7= any combination of the above

18. Do you irrigate all of your irrigable land?

1= Yes 2= No

19. If no, why?

1= low productivity 2= poor quality of irrigation

3= getting sufficient produce by rain fed agriculture

4= poor maintenance 5= 0ther ---

20. In your opinion, how the performance of RWH for irrigation is judged?

1= benefiting 2= insignificant

21. Can you explain about the impact of RWH on forests and land utilization?

1= decrease deforestation problem

2= maximize land utilization

3= worsen land utilization 4= no change in the trend

APPENDIX 3

The following questions are about Non-Beneficiaries of rainwater harvesting programme.

1. Have you participated in the construction of RWH programme?

   1= Yes 2= No ☐

2. If no, why not -------------------------------------

   ----

3. If yes, is it?

   1= on the whole programme

   2= on the reservoir dam

   3= on the canals ☐

   4= at any point of construction in the programme

4. Do you have awareness about RWH programme?

   1= Yes 2= No ☐

5. If yes, what are the advantages and the disadvantages?

   Advantages:

   1= --

   2=--

   3= --

   4= --

   5= --

   Disadvantages:

   1= ---

   2= --

   3= --

   4= -- 5= -------------------------

6. If no, why not? ---------------------------------- ---------------------------------------

--- --

----

7. Do you wish the land you are using will be under your title through out your life?

   1= Yes 2= No ☐

8. If yes, what relations does your feeling have with improving productivity of your land?

   1= it motivates me to improve the fertility and soil conservation

   2= it assures me that the land is mine, and makes me able to take Every care on it

   3= both

   4= doesn't make any difference

   5= other (specify) ----------------- ☐

9. If no, what relations does your feeling have with improving productivity of the land?

   1= I am not motivated to improve fertility and soil conservation

   2= I am not sure that it is my land, and I don't bother much about the care for the land

   3= both

   4= other (specify) ------------------------- -------------- ☐

10. Do you have any conflict with irrigational land users?

    1= Yes 2= No ☐

11. If yes, what are the reasons? ---

    ----

12. If yes, how did you resolve the conflict?

    --- ------------------------------

13. Do you wish to get engaged on the RWH programme?

    1= Yes 2= No ☐

14. If yes, what opportunity do you think you will gain from the programme?

1= high productivity

2= double harvesting of crops using irrigation

3=water availability for home consumption

4= access feeding for livestock

5= all the above mentioned ☐

6= any combination of the above

15. Do you think that you lost opportunities being non-beneficiaries of RWH programme?

1= Yes 2= No ☐

16. If yes, what are the opportunities you lost?

1= --

2= --

3= --

4= --

5= --

17. If no, why not? --

----

18. Do you believe in accept the RWH programme? ☐

1= Yes 2= No

19. If No, what are the reasons that made you still strong not accept the programme?

1= no change of life in the beneficiaries

2= inconsistency of the programme

3= access of rain water in the locality through out the year

4= absence of plots of land

5= lack of finance for the constriction of RWH ☐

20. What do you judge the impact of RWH programme introduction on your livestock holding?

1= negatively affected my livestock holding

2= positively affected my livestock holding

3= has no impact

21. Do you think the development agents create awareness of RWH programme to your local community?

1= Yes 2= No

22. If no, why is that so?

1= lack of capability 2= being careless

3= lack of construction quality

4= availability of water resources in the locality

5= cultural/traditional domination of the Community

APPENDIX 4

Interview questions to the Kebele Administration Chairperson

Date ---

Name of the Kebele Administration --

Interviewee --------------------------------------- sex -----------------------------

1. What are the major problems encountered by peasant households in the RWH programme?
2. In your opinion, what is the impact of the RWH programme to the community as a whole?
3. Is there any problem of land holding size? How do you perceive this problem in this respect?
4. Is there any special support to the beneficiaries of RWH programme?
5. In your opinion, do RWH programme serve the purpose of ensuring food security /income / growth of the community?

APPENDIX 5

Interview questions to the Development Agents

Date --

Name of the Kebele Administration ---

Name of the DA interviewed ---

1. How do you support /help the beneficiaries of RWH programme?
2. Do the communities participate in the construction of RWH voluntarily?
3. Can you make decision concerning RWH programme by your own responsibility or wait for the guidelines of the higher officials (Woreda, zone, etc)?
4. Is there shortage of inputs for the construction of RWH?
5. What criteria are used for constructing RWH?
6. Who determines these criteria?

APPENDIX 6

Interview questions to RWH experts/officials from Woreda Agriculture and Rural Development Office.

Date ---

Name of the Kebele Administration ---

Name of the expert /official interviewed --

1. How is the relation between the Woreda Agriculture and Rural Development Office and the RWH programme?
2. Who is responsible for the construction of the RWH ponds in the locality?
3. How is the RWH programme going on at present time?
4. How does your local community perceive the RWH programme as a means of water availability and alleviation of poverty?
5. Is/are there any Organization /s/ involved in the process and system of the RWH Programme in one or other way? What are their activities?

APPENDIX 7

Picture 1a. River water diversions at the upper stream of the Chelecka River in Abahilme Kebele, March 2005

Picture 1b: Water canal diversion at the lower stream of the Chelecka river in Abahilme Kebele, March 2005

APPENDIX 8

Picture 2: Water canal diversion at Tigo river in Abahilme Kebele, March 2005

DECLARATION:

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sources of materials used in the thesis have been duly acknowledged.

Name: Amare Yirdaw

Signature: ____________

Date: December, 2006