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ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

2012

PRACTICES AND CHALLENGES OF THE AGRICULTURAL USE
OF RAINWATER HARVESTING IN AMHARA REGION
MENZ MAMA MIDER WOREDA

A Thesis Submitted to the School of Graduate Studies of Addis
Ababa University in Partial Fulfillment of the Requirements for the
Degree of Master of Arts in Development Studies
(Institute of Water, Environment and Development)

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June 2009

Addis Ababa University

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2009

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES
(CDS)

Title

***Practices and Challenges of the Agricultural use of
Rainwater Harvesting in Amhara Region, Menz Mama
Mider Woreda***

By

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DEVELOPMENT STUDIES

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ACKNOWLEDGEMENT

I have no a word to say with out praising to God. God, you made me hopeful, courageous and keeping me inspired for all the things I have done during my study, thank you God!

And I would like to express my huge thanks to Dr. Yohannes Abera my research advisor for his insightful comments, genuine encouragements and support to complete the study.

I am very grateful to ERHA (Ethiopian rainwater harvesting Association), Ministry of water resource, and Ministry of agriculture in providing me reading materials. I am also indebted to the college of Development studies staff members for their smooth relation and support provided during the course and the research work.

Again, I would like to extend my appreciation to the Menz Mama Mider woreda agriculture office, the respondent households, the coordinators of FAO and Safety net programs, the kebele extension workers and officials for their willingness and patience to provide the necessary information.

My special thanks also goes to my wife Haregewoin Teshome and her family for their material and financial support. I am also grateful to my friends Birkneh Wolde, Hailemariam Birke, and my brother Gedlu Girma for their immense professional contribution to this study

Finally, I wish to express my sincere indebtedness to Gizaw Sahle, Fisha Tibebe and Tewabe Shimels who helped me a lot during my study.

You all were great!

Emishaw Girma, 2009

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ACRONYMS

ASAL:	Arid and Semi-Arid land
ASE:	Agri-service Ethiopia
CSA:	Central Statistics Authority
DA:	Development Agents
EMA:	Ethiopian Mapping Agency
FAO:	Food and Agricultural organizations
FDRE:	Federal Democratic Republic of Ethiopia
FDG:	Focus Group discussion
GDP:	Gross Domestic product
GHA:	Greater horn of Africa
HH:	Household
HHH:	Household Head
KI:	Key informants
LDC:	Less developed countries
MASL:	Meter above sea level
MOA:	Ministry of Agriculture
MOARD:	Ministry of Agriculture and Rural Development
NAEP:	National Agricultural Extension Program
NGOs:	Non governmental organizations
RELMA:	Regional Land Management institute
RWH:	Rainwater harvesting
RWHT:	Rainwater harvesting technology
SASE:	Semi-arid and Savannah Environment
SPPS:	Statistical package for Social Science
SSA:	Sub- Saharan Africa
SWHISA:	Sustainable water harvesting Institute in Amhara region
UNEP:	United Nation Environmental Protection
WB:	World Bank
WFF:	Work For Food
WOTR:	Watershed Organization Trust

ABSTRACT

This study was conducted with the objective to assess the practices and challenges of RWHT, to examine the factors that affect farmers decision to adopt RWHT, to explore the perception of the local people about the limitation and prospects of RWHT, and lastly to assess the contribution of RWHT to farmers' food security. In order to realize the facts household survey on 100 farm households having equal number of participant and non participant farmers, two focus group discussions with selected RWHT user and non user group of farmers, six key informant interviews with concerned stakeholders were conducted and finally secondary data were used to support the primary data.

The study area was selected through a multi-stage purposive sampling technique while simple random sampling was employed for surveying the RWHT user and the non user farmers. The study employed both qualitative and quantitative methods of data analysis in order to incorporate the facts investigated through discussions, interviews and survey of households. Where the qualitative data were used to triangulate the information collected through focus group discussion and key informant interview. And descriptive statistics and Pearson χ^2 -test were used for quantitative data analysis. The result of Pearson χ^2 -test has shown that total land size of farmers', livestock availability including oxen, access to credit service, saving, labor availability and large family size have positive association with RWHT adoption. And again, the educational status, level of education of household head and source of income from the agricultural sector are positively associated with RWHT.

Furthermore, the result from the qualitative data indicated that the overall trend of RWHT adoption in the study area was found to be increasing. And most of the local people perception was found to be positive to the RWHT. However, farmers are challenged by institutional, technological and financial and environment related problems to adopt and to utilize the technology.

Finally, the study revealed that RWHT improves the food security status of farmers by improving their income from rain fed agriculture, and their assets such as livestock production. Therefore, efforts should be made by the government and other concerned bodies to minimize the structural, institutional ,and farmer related challenges in order to enhance the benefits of RWHT.

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture is the base of Ethiopia economy, which accounts for about 43% of GDP and employing about 80% of the country's population (WB, 2004). Small holder farmers dominate the sector, and it is entirely dependent on rain-fed, with just about 2% of crop land being under irrigation and accounts for about 1.5% of cereal production in the country (WB, 2004). Due to rainfall variability and the high pace of land degradation, the agricultural sector has become unable to feed its population (Daniel, 2007).

Water resource is one of the fundamental resources which have paramount importance for agricultural production as well as for the survival of human and animal life. Thus it needs to be developed and be managed properly in order to enhance its benefits such as economic, social and physical security (Gezahegn et al, 2006). It is also vital for the maintenance of the natural ecosystems on which we ultimately depend on.

The number of population in the highland of Ethiopia is increasing from time to time. The increasing population needs additional cultivated land in order to produce additional food to meet their increasing demand. The quest for additional cultivable land has become so huge that people have begun to cultivate marginal lands. This further led to the degradation of natural resources. In the semi-arid and arid areas the vegetation cover is low, most of the soils are infertile, and the temperature is too high. These have caused low productivity of the agricultural sector due to the prevalence of high evaporation. And again, if the rainfall runoff is not managed it causes sever soil erosion and this brings loss of soil nutrients. Thus the need to change the arid and semi arid areas of the country into productive land is necessary to fulfill the basic needs of the people. And there is a need to have appropriate interventions to address the prevailing constraints using suitable technologies for improved and sustainable agricultural production (Rebeka, 2006).

Today there is a need to collect rainwater into ponds and to use it for small scale irrigation. The process is said to be rainwater harvesting. This is because rainwater harvesting is important to get sufficient water for agricultural production, to minimize

land degradation, and loss of soil nutrients. In addition, rainwater harvesting has paramount importance to maintain ecological sustainability by avoiding runoff erosion and help the farmer to produce more than two times in small plot of land and this further decreases the big land demand of farmers (Alemneh, 2003). Different rain water harvesting systems are available through which rainwater is captured, stored and used when there is water shortage. Therefore, runoff, instead of being perceived as a problem, can be harvested and used for agriculture and domestic purpose (Nega, 2004).

Rainwater harvesting can be defined as a collection and concentration of runoff for productive use to produce crop, fodder, pasture, tree and livestock production (Nigigi, 2003). Even though water harvesting is not a new concept to many parts of the country, it received policy backing and has been implemented on a massive scale recently (Gezahegn et al, 2006). Different levels of water harvesting technology, material and financial input have been a recent development in many regions of the country. Water harvesting technologies are introduced with the aim to reduce poverty and increase food security on a massive scale, to irrigate and produce high value crops and provide water for livestock and household consumption (Ibid).

Beginning from the ancient Axumaite period, the traditional Ethiopian farmers have developed experience about how to harvest rainwater traditionally. Again, as a response to the 1971-1974 droughts in Tigray, Wollo and part of Harerge regions rainwater harvesting was practiced with the introduction of food-for-work program (Gzahegn et al, 2006). The program was intended to generate employment opportunity to the people who are affected by the drought. The promotion and application of rainwater harvesting technology as an alternative intervention to solve the problem of water shortage have been started through government initiated soil and water conservation programs. From that time onwards the technology has been extended to the other parts of the country with very limited coverage. The low level of community participation and declining attention were some of the major reasons for the limited coverage (Ngigi, 2003).

Diverting rivers and building small dams in order to increase small-scale irrigation system are the major areas of emphasis of the country water policy (Gezahegn, 2006). Many Cooperating sponsors prefer this intervention to address food security and

livelihood in the country. Ethiopian farmers have historical experience of building small schemes on their own initiative and establish their water use association with government material and technical support (Daniel, 2007). Regional governments are equally involved in the construction of modern small-scale irrigation schemes.

As to Gezhagn, et al. (2006) much of the money allocated for food security program in the country was invested by the regions for the implementation of rainwater harvesting program, many of which are based on the construction of ponds and cisterns planned and implemented by the Ministry of Agriculture and Rural development (MOARD). In line with this water harvesting tanks and ponds at a household level or village level are suggested as a practical and best alternative to improve the lives of rural people at little cost and with natural rainfall (Rebeka, 2006).

The contribution of water harvesting to stabilizing agricultural production becomes obvious. In addition to its contribution to improve food security, water harvesting helps to improve water availability for multiple uses.

Appropriate water harvesting combined with conservation tillage to make water available with plants can maximize infiltration, mitigate short dry spells, and improve soil fertility, leading to average yield increases up to four times from the current level (Gezahegn et al., 2006).

Like the other regions of Ethiopia, in Amhara Regional State there is a growing ambition to use rainwater resources to bring improvement in the agricultural sector and in any aspect of human life. The idea has got grate acceptance and supported by the federal government of the country (Daniel, 2007). In the national food security strategy of Ethiopia, RWH is the main pillar (Rami 2003). In order to increase the agricultural production of the region, particular to North eastern part of the region that are drought prone areas, rain water harvesting and management has paramount importance for food security of the society.

1.2 Statement of the Problem

The continued food demand in Ethiopian is expected to be doubled in the next few years (Awulachew, 2005). On the contrary, the amount of rainfall needed to meet this demand is unlikely to increase. This is not only because of insufficient amount, but mainly due to the annual variability and high concentration in time (Rami, 2003).

In order to reverse this problem the need to develop coping mechanism in the country and in the study area as well has got policy backing by the government (Daniel, 2007). Like any other part of the country, the study area of Menz Mama Mider woreda depends on small holder rain fed agriculture. In order to promote the sector effective use of rainwater resource is vital and RWH is one strategy which can be used to increase agricultural productivity and improve the households' income (Fekadu, 2008). The study area is characterized by seasonal variability of rainfall, drought and low moisture amount in the soil. These are major factors for the prevalence of repetitive food insecurity of the people in the woreda (ASE, 2003). In order to enhance agricultural production in the woreda the government and other non governmental organization have begun the implementation of RWH since 2003. But, no significant change is observed on the food security status of the local community in the study area of Menz Mama Mider woreda. Although reasons for the failures have been identified at a larger scale for Amhara and Tigray (Rami, 2003, Gezahegn et al, 2006) local level factors have not been studied for the woreda.

Due to this reason, there was a need to assess the practices and challenges of the existing rainwater harvesting systems in the study area of Menz Mama Mider woreda. In addition, there was a need to investigate rainwater harvesting determinant factors that affect farm household decision to adopt the technology, to examine the perception of the local community towards the limitations and prospects of the technology and to explore the role of RWH for food security in the study area.

1.3 Objectives of the Study

The general objective of the study is to assess the agricultural use of rainwater harvesting in the selected kebeles of Menz Mama Mider woreda having the following specific objectives.

1.3.1 Specific Objectives

- ❖ To explore the practices of RWH in the study area
- ❖ To assess the perception of the local community towards rainwater harvesting
- ❖ To identify the factors that affect household decision to adopt rainwater harvesting
- ❖ To explore the challenges of RWH in the study area
- ❖ To examine the role of RWH for food security in the study area

1.4 Research Questions

With the general frame work indicated above the following fundamental questions are raised to guide the study.

- ❖ What are the practices of rainwater harvesting in the selected kebeles of the woreda?
- ❖ What is the perception of the people towards rainwater harvesting?
- ❖ What are the major determinant factors that affect household decision to adopt rainwater harvesting?
- ❖ What are the challenges of RWH in the study area?
- ❖ What is the role of RWH to farmers' food security

1.5 Significance of the Study

The findings of this study is expected to identify the challenges of rainwater harvesting practices in the study area and initiates the concerned bodies such as government officials, non-governmental organizations, development agents and others to give due attention for the solutions of the problems.

Furthermore, it is the researcher's strong belief that the results of the study could possibly apply to other similar areas in the country as well. And the study may also serve as a base for further research work in the study area.

Lastly, it gives general and specific recommendations for the improvement of rainwater harvesting technologies.

1.6 Scope and Limitation of the Study

This study specifically focuses on exploring RWH practices, solicit local people's perception towards RWHT, investigating the major factors that affect household decision to adopt RWH technology, and identify RWH challenges in the study area. Lastly, the role of RWH for farmers' food security in the study area was assessed. The study area is limited to purposely selected three kebeles namely Angewa, Aguatwha and Kolomargefia, where the number of rainwater harvesting technology adopters is high in comparison with the other kebeles of Menz Mama Mider woreda.

The study is based on a field survey of 100 farm households in which half of the respondent households using rainwater harvesting ponds in their agricultural production process and half of them are non adopters of the technology.

As the components of RWHT are too wide, it may not be possible to address all the issues in this paper due to limited time and resource. And again, the findings of the research could be more reliable if the researcher includes large number of respondent farmers in the survey. But due to financial shortage the study is limited to only 100 randomly selected farm households. Hence, these can be taken as the major limitations of the study. Nonetheless, the study is expected to be sufficient for academic fulfillment.

1.7 Organization of the Study

This thesis has six chapters. The first deals with the introductory section, the problem and objective of the study including the significance of the study. The second chapter deals with the principles and definitions of rainwater harvesting technology. The third chapter presents the review of literature. The fourth part describes the study area, the methodology and the conceptual framework of the study. And chapter five is about the results and discussion of the study followed by chapter six which deals about the conclusion and recommendation part of the study.

CHAPTER TWO

PRINCIPLES AND DEFINITIONS OF RAINWATER HARVESTING

2.1 Meaning of Rainwater Harvesting

Rainfall is the most important sources of water which may quickly evaporates, seep into the soil or may run as surface runoff (Nega, 2005). If the water evaporates, it is lost into the atmosphere though it may fall again somewhere else as rain. But if the water seeps in, it may stay in the soil where plant roots can reach it or it may filter down into the ground to recharge the ground water. Too much rainfall can result in excess runoff or flood. Water that runs off the surface may remove small soil particles and carry them away, causing erosion. Rainwater harvesting is a concept of utilizing this runoff water for any productive uses.

Water harvesting is defined as the collection, storage and delivery of rainwater for later use in the production of biomass such as food crops, pasture and trees, livestock production and for domestic purpose (Malesu et al, 2007). As to the same author RWH is defined as the process of collecting and improving the productive use of rainwater and reducing unproductive runoff. It often involves collecting rainwater from catchments area and channeling it to cropping area.

The term rainwater harvesting is used in different ways and there is no universally agreed definition (Ngigi, 2003). For instance, Gould in 1999 states that RWH is a general term that describes the small scale concentration, collection, storage and use of rainwater runoff for both domestic and agricultural purpose. Ngigi (2003:6) defined RWH as the process of collecting, concentrating, diverting, storing, utilizing and managing runoff for productive use.

Since the focus area of this research is the agricultural use of rainwater harvesting, the two definitions given by Ngigi and Malesu seem more meaningful to this study while the definition given by Gould includes the use of RWH for domestic purpose which is out of the scope of this research work.

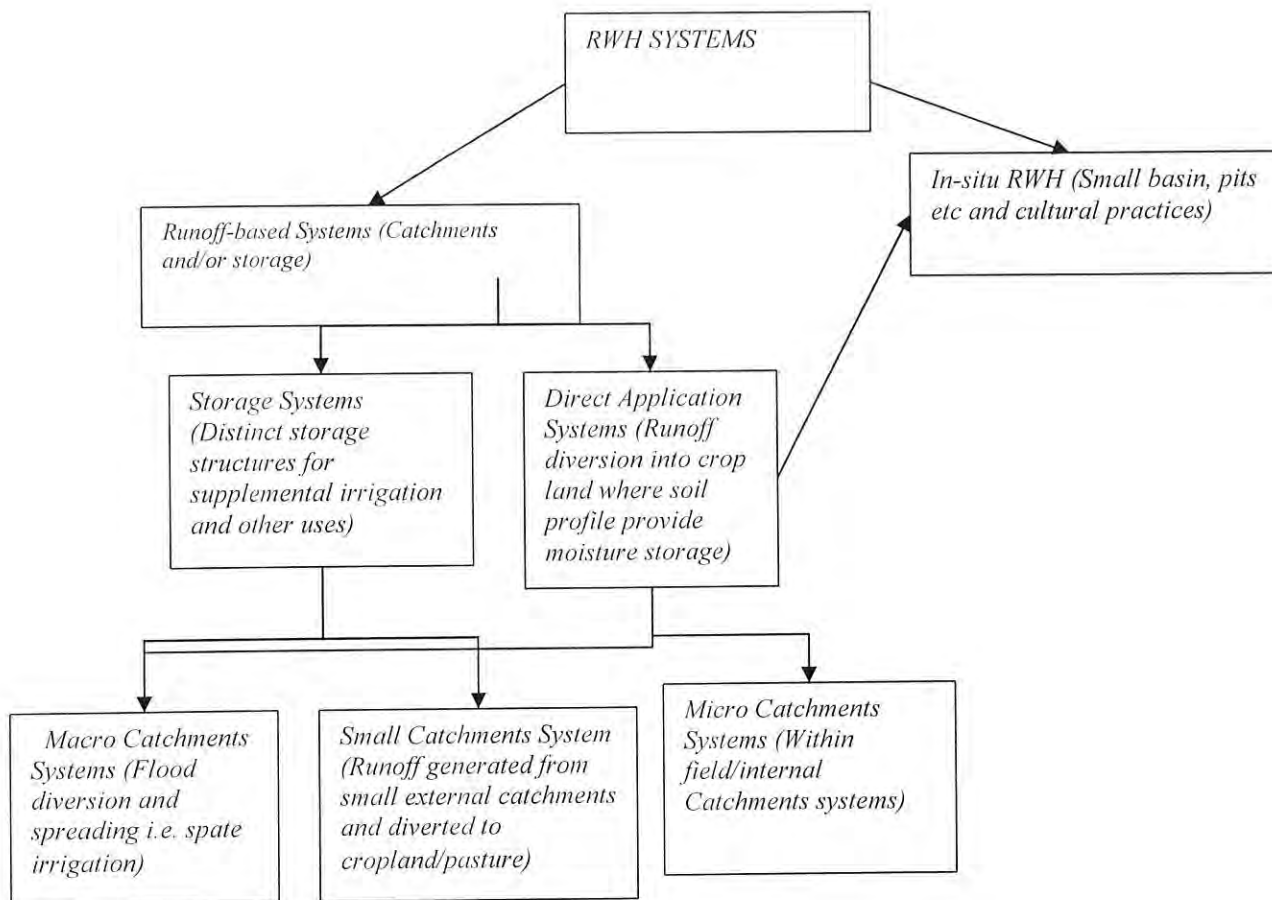
2.2 Where to use Rainwater Harvesting?

Rainwater harvesting can be applicable in all agro climatic zone. In general the technology can be applicable in the following circumstances:

- ❖ In dry environment, where low and poorly distributed rainfall normally makes agriculture production low.
- ❖ In areas where other permanent water sources like rivers, springs, etc are not available or uneconomical to develop and use them.
- ❖ In rain fed areas where crops can be produced, but with low yield and with high risk of failure.
- ❖ Where water supply, for domestic and animals is not sufficient
- ❖ In ASA areas, where the potential for crop production is diminishing, due to environmental degradation. Providing water to these areas through rainwater harvesting can improve the vegetation cover and enhance resource conservation

2.3 Classifications of Rainwater Harvesting Technologies

Rainwater harvesting has no a universally agreed classification like that of its meaning. But as to (Ngigi, 2003:23) RWH except in-situ water conservation has the following components. These are runoff producing catchments, runoff collection (diversion and control) structures, runoff storage facility (either soil profile in cropland or distinct structure (farm ponds, tanks, water pans, earth dams, sand dams, surface dams, etc). The clear presentation of RWH classification has been shown in figure 2.1.



Source: Adopted from Ngigi, 2003

Figure 2.1 Classifications of RWH systems and technologies

The classification shown above is based on the runoff generation process, type of storage, use and size of catchments.

Runoff generation process

The generation process can be classified either into runoff farming (i.e. runoff based system) and in-situ water conservation. In-situ water conservation is the process of conserving rainfall from where it falls.

Runoff storage criteria

The runoff storage criterion yields two categories. It can be classified into soil profile storage (direct runoff application) and distinct storage structures for supplemental irrigation, and for other uses (Ngigi, 2003). In addition this system includes storing rainwater in cistern and ponds.

Size of catchments

As can be shown in figure 2.1 the direct runoff based has three categories on the size of the catchments systems. These are micro catchments (with in the field or on farm system, macro catchments and small external catchments). The small external catchments are also said to be non land micro catchments (Rebeka, 2006).

Small external systems and macro catchments systems are categorized under external ex situ systems. Macro catchments systems are large external catchments producing massive runoff (floods). This runoff is diverted from large fields, rocky surfaces, gullies and ephemeral streams to crop land. Macro catchments with large storage structures could be used for large scale and community based projects (Ngigi, 2003).

The concept of small external catchments includes collecting runoff from road drainage and adjacent fields by using runoff storage structures for small scale land users. Micro catchments rainwater harvesting refers to collecting and spreading runoff on to adjacent cropped land without using any special structures. It is also said to be internal (micro and in situ) systems. If these systems are well done, they have a potential of increasing yield from 30-90% in semi-arid areas (Malesu et al, 2007). The method is targeted to increase the amount of water stored in the soil profile by trapping or holding the rains where it falls.

2.4 Challenges of RWH Implementation

The integration of different forms of RWH structures would enables to maximize promotion and adoption of RWH systems. The best way of adopting RWH is either by improving or upgrading the existing type of system is the most viable option of technological innovation (Nigigi, 2003).

Thus, the adoption of RWH technology irrespective of the benefit accrues from it, the knowledge of socio-economic and cultural dynamics on the part of the technology adopters and the farmers or the community perception is important. This integrated approach makes possible the challenge to be averted.

The other problem of adoption of RWH is the lack of awareness creation and sensitization. RWH having been for round hundreds years still no sufficient attention has been given on the parts of policy makers. As a result, no sufficient documentations that shows different experience, and professionals in the field. Thus, the adoption of it may be hampered (Nigigi, 2003; Rami, 2003).

The level of economic situation or the degree of impoverishment of the adopter is one of the essential factors that can affect the rate of adoption. For instance, the adopters in *Kobo* reveals that due to the high level of farmers in the area were sub-letting and offering their labor for survival as a result they were not engaging to the implementation of RWH (Nigigi, 2003).

The knowledge of the technology and their specification and its suitability to the adopters matter most to foster the adoption of RWH (Nigigi, 2003). Lack of expertise in the constructions and build up of RWH ponds as well as inadequate and lack of sufficient training has got a paramount negative effect to the adopters (Rami, 2003).

The absence of appropriate legal framework, policy and institutional issues may also significantly affect the adoption of RWH. For instance, in Tanzania the social development committee responsible for the promotion of RWH found to have no legal support and the committee has no knowledge about RWH. Thus, the result that may obtain from such group may be distorted. Similarly, Daniel (2007) reveals the same fact that the lack of policy focus, inadequate policy and institutional issue can significantly affect RWH adoption.

Depending on the local context the adoption of RWH may be affected by gender differential (Danile, 2007). For instance, in *Kobo* both male and female have equal chance of access to resource; however, the responsibility for decision making is given to male. The experience from Uganda indicated that both female and male have equal decision making power for the adoption of RWH (Nigigi, 2003).

The availability of building materials, financial strength to have access for complementary input and to have a structure that much to the local soil geology type are

the other important factors for the promotion of RWH. Experience from Dalanta Ethiopia indicated that 1000 ponds have been collapsed because the structures were built in a soil type that does not support it (Rami, 2003).

CHAPTER THREE

LITRATURE REVIEW

Agriculture is a major source of employment and took the largest share of the national domestic product of less developed countries/ (LDCs/ (Daniel, 2007). And again, the sector is the most water-demanding sector and mainly depends on rain fed crop cultivation.

According to FAO (1993) studies showed that irrigation has shown some positive impacts in increasing agricultural productivity and improves household income level. However, the technology is proved to be costly and only benefit farmers with having large plot size (Malesu et al, 2007)

In line with the above mentioned points large scale dam and irrigation projects have not been widely implemented in Ethiopia as they have proved to be expensive and demanding in construction and maintenance (Rebeka, 2006)

Therefore, water harvesting tanks and ponds at the village level or household level are proposed as a practical and effective alternative in order to improve the life of farmers in semi-arid and arid areas of sub-Saharan Africa (Ngigi, 2003). As to Takele (2002) household water harvesting can be performed mainly by the farmers themselves. And this could supplement natural rainfall and help farmers to resist drought time and further encourage them to be less dependent on outside help in harder times.

The different dimensions of water harvesting in the region of sub-Saharan Africa has still to be investigated. Once upon a time, irrigation practices were accepted as the solution of water shortage to sustain agriculture. But at the end the technology proved to be costly, too technical, and a source of environmental hazards (Malesu et al, 2007). A number of rainwater harvesting ponds were set up in the past few decades in sub-Saharan Africa as a solution to prevent crop failure during the period of drought to supplement rain fed agriculture. But due to lack of technical skill and coordination problem only few of them succeeded (Ibid)

Based on the UNEP (2005) report rainwater harvesting project have been carried out in about 700 countries of 15 provinces in semi-arid and humid areas covering two million km^2 and with a total population of 0.36 billion. By the end of 2001, about 12 million water cellars, tanks and small ponds were built with a total storage capacity of 16 billion m^3 supplying water for domestic use for 36 million people and supplemental irrigation for 2.6 million m^2 of dry farming land. And the report further stated that this helped the people to have access for water and engages in agricultural production hence improving food security and alleviating poverty.

The Chinese experience mainly in Gansu province of central China can be a lesson for the semi-arid and arid areas of sub-Saharan Africa. Gansu province of China is one of the driest and poorest parts of China, rainfall is low, and so is the ground water reserve and this make life hard for the people of China in Gansu (Gould, 1999). This province was severely hit by the worst drought in the year 1995. In response to this the Gansu research institute for water conservancy in collaboration with the local government of the province introduced a water catchments project called '121' projects where the government supported the local people to prepare catchments, water storage facility and catchments basin or planting area. And at the end of the day the people in Gansu were able to solve the problem of water shortage in the region for their drinking, livestock and for crop production (Gnadlinger, 2000). Gnadlinger further stated that soon after that time onwards rainwater harvesting has become a strategic measure for the social and economic development of China and in the semi-arid and arid regions.

Once upon a time rainwater harvesting technology was regarded as the dying tradition of India. But now a day the technology has been reviving in many parts of the country particularly in rain scarce areas. Derwadi village in the central state of Maharashtra, is one of such dry village of India. A remote village with no assurance to drinking water, with farming being mainly rain fed based and agriculture production can not provide food more than three months. Derwadi used to be a desperate village with no employment opportunity for the community and where schooling was a distant dream for many of the children in the village. The community established a link with an Indo-German watershed

development NGO called watershed organization trust (WOTR). This organization helped the village community to construct contour trenches, farm and contour bunds, and check dams. With this action the life of the village community were improved and they began to fulfill their far distant dream by using the harvested water for drinking and irrigation as well. Soon after the adoption of the technology, the people began to diversify their production from traditional millet to other host of crops ranging from various vegetables to cotton, but also managed to produce crops in surplus and be able to sell, perhaps for the first time to big towns. And were able to send their children to school, forming self help association that enabled them to organize and carry out different socio economic activities.

The Kenya case study of Mwala division on the impact of RWH has shown that harvesting runoff water for supplemental irrigation is a risk averting strategy in a place where crops have to depend on rainfall that is highly variable both in distribution and amounts. By using under ground spherical tanks having a combined capacity of 60m^3 , seasonal water for supplemental irrigation for an area about 400m^2 was guaranteed. With rainwater harvesting, farmers have diversified to include horticultural cash crops and keeping dairy animals. For instance households with supplemental irrigation earn US \$735 (per ha) from each crop compared with US \$ 146 normally earned before using RWH from maize production and this contributed to the food security of the farmers in Mwala (RELMA-in-ICRAF,2004).

During the 1990s the southern province of Zambia was faced unprecedented levels of food insecurity, hunger and general poverty. The provision of food, seed and fertilizer relief by the government were considered as a norm by the people rather than expectations. In 2002/03, over 12% of the farm households were estimated to have adopted conservation agriculture technologies incorporating the use of rainwater harvesting. This was estimated to involve at least 50,000 hectares. At that time the experience of Zambia shows that crop yields have on the minimum doubled. The increase in production at household level has also introduced the rapid re-birth of a cash economy among the communities and brought a considerable effect for the enhancement of the farmers in the southern province of Zambia (UNEP, 2005)

Rainwater harvesting is practiced in Dodoma, Kilimanjaro, and Mwanza areas of Tanzania in one form or the other form. In this region the most prevalent harvesting systems are the agronomic practices like mulching and adding manure so as to raise the water holding capacity of the soil, runoff utilizations that is used mainly for growing maize, rice and other high water demanding crops, diversion and utilizations of ephemeral streams and the use of rainwater harvesting with storage (Hatibu et al, 1999)

The same author in 2004 tried to quantify the effect on farmers' income and living standards of different rainwater harvesting methods, taking two districts, Maswa from north and Same districts from eastern part of Tanzania. Both micro and macro catchments and rainwater harvesting with storage are practiced in the two regions in order of decreasing. Which means in-situ is more prevalent in both regions followed by micro and macro catchments. The harvested rainwater is mainly used for maize production (Same area) and increase the production by four fold of rain fed yield level and two fold for rice (Hatibu et al, 2004)

Beginning from the ancient Axumaite period, the traditional Ethiopian farmers has developed experience about how to harvest rainwater traditionally.

There are a number of examples that show the rich experience behind the traditional Ethiopian agriculture. Farming communities in the semi-arid areas have managed to deal with their environmental challenges and constraints through different locally innovated technologies and adaptive socio-cultural set ups. These include the traditional soil fertility management practices, flood harvesting and in-situ moisture conservation (Birhanu et al., 2000).

Moreover, rainwater was harvested and stored in ponds for agricultural and domestic water supply purpose, since 560 B.C in the pre-Axumit period (Fattovich, 1990). It was a time when ancient monasteries, churches, and castles were engaged in rainwater harvesting for irrigation purposes and water supply. Still the evidence of the remains of ponds that once used for irrigation and a roof water harvesting set up are visible in the remains of one of the oldest palaces in Axum; in the palace of the legendary Queen of

Sheba (Fattovich, 1990). The same source indicates that other evidences are found in the remains of the old castles in Gondar, constructed in the 15-16th century, which used for religious rituals by the kings.

Even to this day, there are several traditional RWH technologies in Ethiopia, which have been used by communities in areas of water shortage since the time immemorial. For many traditional communities in rural areas where natural sources of water are scarce, collection of rainwater from pits and excavated ponds are common practices. For instance, *Birkas* used for storage of rainwater in Ogaden, runoff irrigation practices in Churcher plains, around Mahoni and Waja near Alamata, the Geto valley in North Omo, parts of Eastern and Western Hararghe and in many other places of the country there are similar practices. Similarly, the people in Konso, Gidole and many other parts of the former Gamo-gofa region have been exercising the art of conserving soil and water (Habtamu, 1999). 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 successfully 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. Hence, it is a symbol of struggle for survival by the Konso people against the adversaries of nature (Getechew, 1999).

In response to 1971-1974, drought years the government took RWH as an alternative way of intervention for water scarcity and water management with the introduction of food-for-work (Kebede, 1995, as quoted in Nigigi, 2003).

Currently, the Ministry of Agriculture of FDRE has launched the National Agricultural Extension Program (NAEP), and water management in particular RWH is included as one of the packages contained in the extension system which designed to enable attainments of food self sufficiency (Birhanu et al., 2002). Relevant interventions in this regard have been included in the soil and water conservation action plan (2001-2006) of the MOA. Objectives of the action plan are focus on the rainfall regimes of the target areas. Such specific technologies are designated with respect to the interventions for moist and moisture stressed areas. RWH interventions intended for moisture stressed and pastoral

areas including both on-farm rainwater conservation and off-farm RWH (MOA, 2001). These interventions include conservation of rainwater by making use of physical structures and RWH for domestic and irrigation purposes through pond and micro-dam construction and roof catchments schemes (MOA, 2001).

The case studies in kobo area of Amhara regional state in Ayub and Jarota KA reported that RWHT has significant contribution to increase agricultural production. According to the PRA findings, Sorghum yield in Ayub KA could be doubled with the availability of flood water, while in Jarota KA lack of flood water may cause a total failure of sorghum crop. Further the study shows that pepper yields increase by up to 400% with application of flood water (Nigigi, 2003). However, in this KA the study revealed that institutional problems including absence of developmental research, land tenure issue of farmers and river bank erosion, remains to be the major challenges of the technology.

As to Rami (2003) the case study of Meket in North Wollo disclosed that pond site selection is an important issue to adopt and utilize rainwater harvesting. In Meket on the basis of the agro-ecological zone of the area, some sites are good for pond adoption, while some sites are investigated as better for well construction. In the lowlands of Meket, due to transportation problems, construction materials including cement and heavy plastic linings adoption of RWHT became impossible. And in the mid and highlands of Meket woreda, the prevalence of swampy plains of black cotton soil makes the area less suitable for ponds and tanks than lowland areas. In this area as mentioned by the same author, lack of runoff due to the construction of the pond on a totally flat area away from water catchments caused the concrete pond to be empty.

In general, flaws in the design of the structure, insufficient building experience, lack of skilled personnel, and shortage of material are some of the major problems faced Amhara and Tigray regions. Currently, a very large number of completed tanks simply do not hold water and are leaking. This of course does not necessarily mean that the concept is wrong. However, it does point to issue that need to be addressed if water harvesting is to have the impact to improve food security that the government and people of the country desperately wish to see (Rami, 2003)

CHAPTER FOURE

BACKGROUND OF THE STUDY AREA, METHODOLOY AND CONCEPTUAL FRAMEWORK

4.1 Background of the Study Area

Location

Menz Mama Mider woreda is located in Amhara regional state North shewa administrative zone. The capital of the woreda Molale town is located at about some 256 km north east of Addis Ababa. The astronomical location of the woreda is $10^{\circ}5' N$ to $10^{\circ}10' N$ and $39^{\circ}35' E$ to $39^{\circ}40' E$ latitude and longitude (EMA, 1992)

LOCATIONAL MAP OF MENZ MAMA MIDER WOREDA

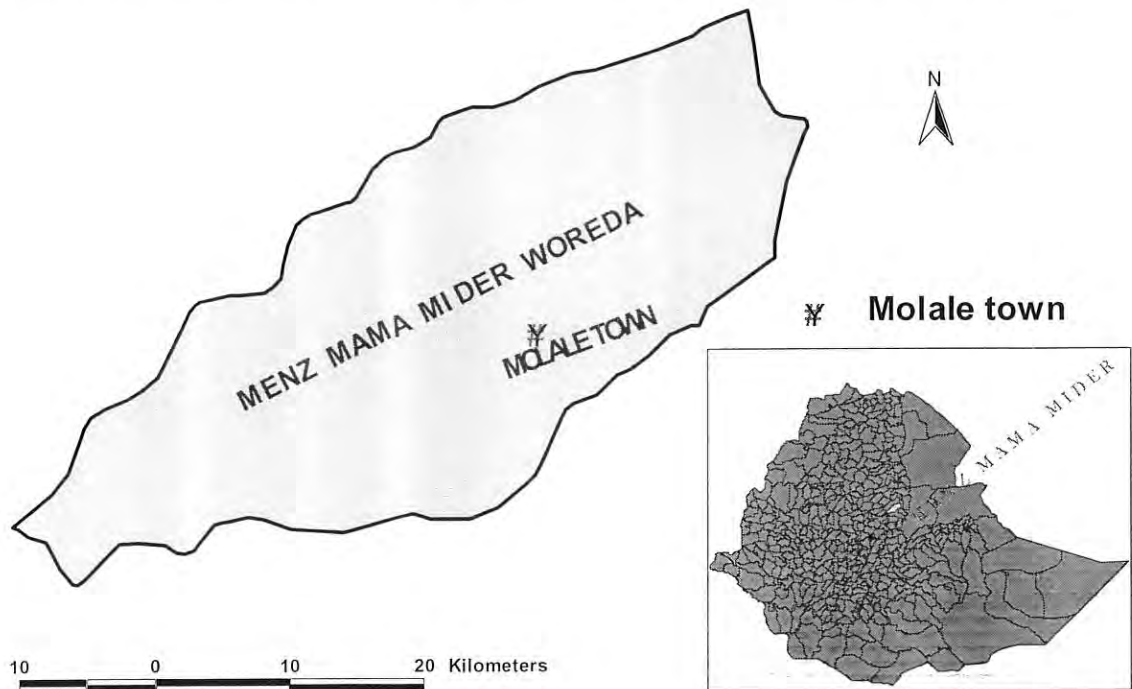


Figure 4.1 Map of the study Area

Population

Based on the data obtained from the 1994 census result, the total population of the woreda is reached about 19, 000 in all the Kebeles of the woreda.

Climate

Argo-climatically, the study area is divided into three zone out of which 35% of the area is Dega, 40% and 25% of the area is woina dega and Kola respectively. The altitude of the woreda ranges from 2001 to 3000 masl. The average annual temperature and annual rainfall is estimated to be 740mm and 12.5⁰c respectively (ASE, 2003)

Topography

The topography of the woreda consists of 40% plain and undulating plateau, 50% hills and 10% steep slope and cliff. The current land use category of the woreda is classified into 60% cultivated, 15% grazing, 10% settlement, 10% plantation around homestead and 5% waste land

Agriculture

Agriculture is the major source of living for the community in the woreda under study. Mixed farming, which includes crop and livestock production, is practiced in the area. In the woreda, more than three types of cereals, pulses and herbaceous legumes are produced. Most farmers kept livestock such as sheep, goat, equine, cattle and poultry, of which sheep is the dominant livestock type. It is used as the living bank and the major coping strategy during lean period.

The current agricultural policy is reflected in the on going agricultural extension package (woreda bureau of agriculture, 2008).

Vegetation cover

The natural vegetation cover in Menz Mama Mider woreda is very negligible other than few homesteads and community wood lots of eucalyptus trees. The eucalyptus trees are hardly growing as they were planted on rocky steps with poor communal forest management. Some remnant indigenous species are seen around the churches. These species had been so severely destroyed as the land escape is virtually bare.

Socio-economic condition

As to the revised report of Agri-service Ethiopian, population pressure, land fragmentation, size of land per household, land tenure system, back ward farming practices, inappropriate extension package and recurrent drought have been the main causes for food insecurity in the area for years. As result people in the area have been dependent on food relief distribution.

During lean period and crop failure, farmers sell small ruminants and buy cereals. Opportunities for alternative sources of income are inadequate in the area. Male migration to towns in search of jobs has also taken as a coping mechanism that in turn increases women households' burden.

As of 1995 both male and female have become entitled to equal use of land, however due to lack of power and access to credit to buy improved agricultural inputs female households are forced to engage in sharing of cropping arrangements and unable to fully benefit from their land. As a result they tend to be food insecure most of the time.

Abduction, rape, beating wives, genital mutilation, and early marriage are among the major widely practiced traditions of the area that negatively affect women.

Traditional institutions like 'iddir' 'ikub' function as social solidarity units and also their role in social aspect is paramount. However their contribution to the socio economic well being of the people is limited.

4.2 Methodology

The methodology of the study focuses on the over all research process including research design, description of the study area, and sources of data, method of sampling and sampling size and the method of data collection instruments used.

4.2.1 Research Design

To gather adequate information and to get individuals, groups and institutional views both the qualitative and quantitative methods were employed for the study.

4.2.2 Selection of the Study Area

Firstly, Menz Mama Mider woreda was purposively selected, this is because the researcher knows that the area is one of the most drought affected area in Amhara regional state where rainwater harvesting technology is practiced.

Secondly, from the total of 19 kebles in Menz Mama Mider woreda, 9 kebele were found to be participant of RWHT implementation. Of these three of the kebeles were purposively selected based on the woreda agriculture office information by giving due emphasis to the number of rainwater harvesting participant farmers, the type of pond adopted and the time when farmers get involved into the technology were considered . Namely, Angewa, kolomargefia and Aguatwha kebeles were selected for the study. These three kebeles comprise 45% of the RWHT adopter farmers in the woreda. In addition, care was taken to include both the plastic and cement lined pond to compare their effectiveness, farmers' acceptance and to investigate the problems for each types of ponds.

Thirdly, farm households in the three selected kebeles were stratified as rainwater harvesting participant and non participant groups by taking the list of the total households in each Kebele from the woreda administrative office and list of RWH technology users were taken from the woreda agriculture natural resource department bureau.

Finally, simple random sampling techniques using lottery method were employed to sample individual respondents from each group of the strata as farm households are assumed to be homogenous in their group.

The secondary data obtained from the woreda administrative office and the woreda agriculture natural resource department bureau revealed that there are about 3216 non-participant farmers and 732 RWH technology participant farmers in the study area. Thus due to shortage of time and financial constraints to include all the farm households in the selected kebeles 100 farm households were taken from both the participant and non-participant groups for comparison purpose. From each stratum 50 respondents were taken.

4.2.3. Methods of Data Collection

4.2.3.1 Primary Data Source

The study was based on sample rainwater harvesting user and non user farm household members cross sectional survey using structured questionnaire organized in a logician order of presentation. The survey generated both qualitative and quantitative data in line with:

- Socio-economic and demographic characteristics of the community.
- The practices and challenges of rainwater harvesting implementation
- The perception of the local community towards rainwater harvesting technology.
- The role of rainwater harvesting to farmers' food security.

Key informant interview

Detailed key informant interview was held with the following particular sections of the society:

- Purposely selected household members who are involved in rain water harvesting practices which include three people in each of the three kebele.
- With the kebele administrative officers, and woreda agriculture and nature resources department bureau.
- With the extension workers in each of the three selected kebeles
- With the representatives of FAO and safety net program coordinators.

Focus group discussion

Focus group discussion was another qualitative method of data collection for the study. The researcher conducted two focus group discussions with those households in the three selected kebele who are rainwater harvesting technology participant and non participant farmers having a total of twelve members in each group in two sessions. In this FGD the researcher was responsible to guide directions and promote active group participation. All contents of the discussion were recorded and later transcribed.

4.2.3.2 Secondary Data Source

Secondary data that are relevant to the research work such as water harvesting related publications and books, conference proceedings, water harvesting related materials available on the web sites and internet, previous works done as master thesis and PhD dissertation, were used. In addition, relevant documents were obtained from the office of Agri-service Ethiopia, the woreda administrative office and from the office of agriculture natural resource department bureau.

4.2.4 Method of Data Analysis

To meet the specific and general objective of the study both qualitative and quantitative methods of data analysis were used due to the reason that RWHT adoption determinant factors are many and complex.

The data which was collected by structured questionnaire mainly analyzed by descriptive statistics with the help of statically package for social science (SPSS). Some statistical tests such as Pearson χ^2 -test to see the association of RWHT adoption with factors like land resources, livestock availability, access to credit service and saving were used. In addition information which was obtained from focus group discussion, and key informant interview was summarized and used in the triangulation of evidences and facts. Parts of the closed questions of the questionnaire were discussed using tabulation and cross tabulation of variable with percentage values.

But information from open-ended questions, key informant interviews, and focus group discussions were discussed through qualitative description.

4.3 Conceptual Frame Work

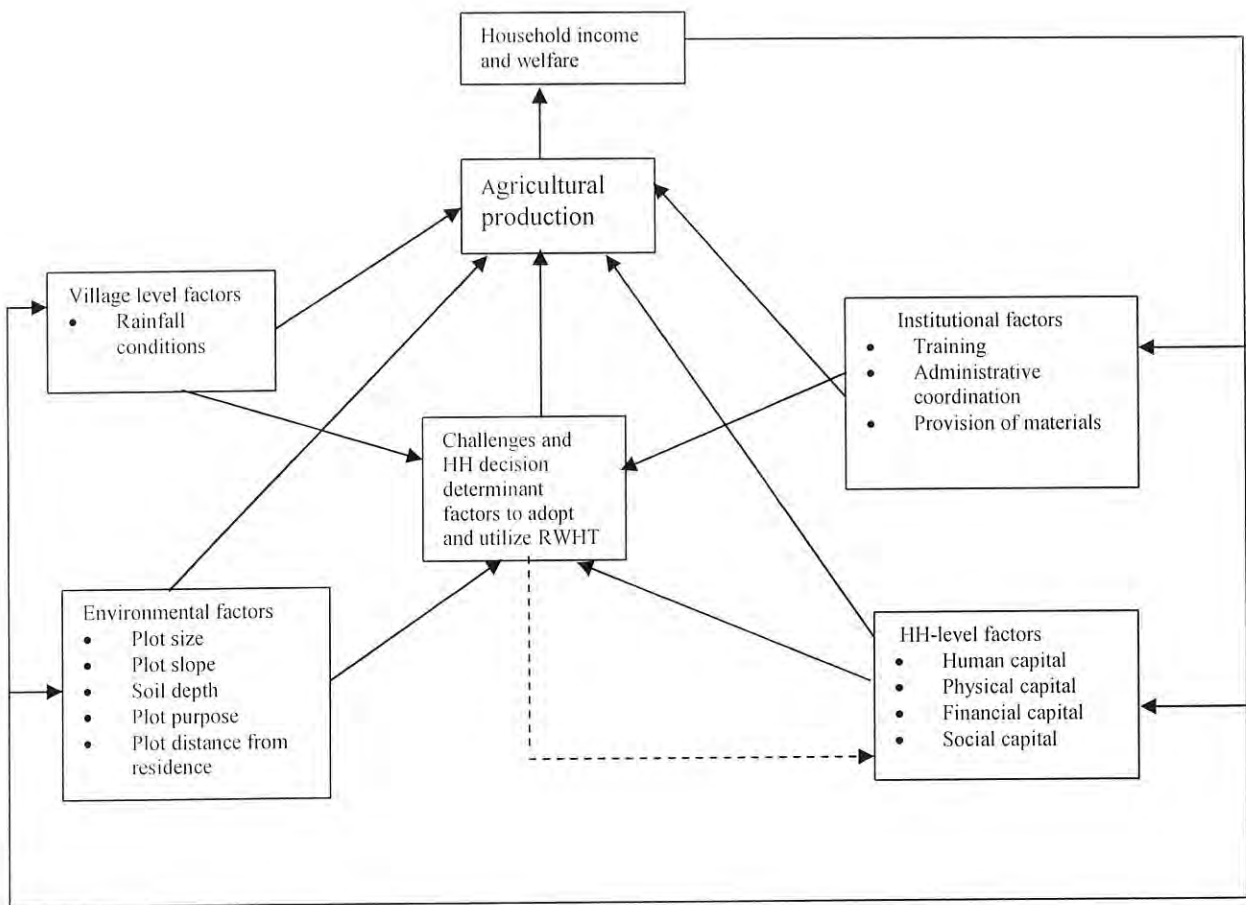


Figure 4.2 schematic presentations of RWHT adoption decision factors and challenges.

Key: The solid and dashed lines show factors which have direct and indirect impact respectively.

The major factors in this study as shown in figure 4.2 that challenge farm household to adopt and utilize RWHT are household level factors, plot level factors, village level factors, and institutional factors.

The village level factors that can challenge farmers' agricultural production and RWHT adoption decision is the variability and amount of rainfall. As the rainfall variability decreases and amount of rainfall increase then the agricultural production of farmers could increase and farmers may not be initiated to adopt rainwater harvesting technology.

In addition, the plot fertility level, slope, depth, and distance of the plot from the household resident could directly affect agricultural production and the adoption of RWHT. Farm households having medium land slope type, shallow soil plot depth, and large plot size around their home have high probability to adopt RWH technology and also they could increase the amount of yield that could be produced.

The other most important factors which can affect agricultural products and challenges farmers adoption decision and utilization of RWH are household level factors. These include human capital, physical capital, financial capital, and social capital. The human capital includes sex of household head, household size and educational status of the households including the household head. Where as farmers physical capital includes land ownership, livestock and asset endowment. Furthermore, households' social capital includes type of local organization and type of association that the household head is involved in. And, finally the financial capital includes household's saving and credit need, credit access and credit obtained. The institutional factors that can challenge farmers' adoption decision and implementation of RWHT include training, provision of material such as plastic, cement, improved seed and pedal pump. If government gives training to the farm household about RWHT, provide improved seed, pedal pump, cement and other pond construction materials farmers can adopt the technology and can also increase agricultural productivity.

The technology adoption decision could increase the farm household's agricultural yield by improving the availability of water during the dry spell periods. It has also the potential to increase the moisture of the soil and thereby improve the fertility of the soil, which in turn has an impact to increase the agricultural yield harvested.

Agricultural productivity can be directly affected by farm household's decision to adopt rainwater harvesting technology, or can be indirectly affected by the technology through the use of inputs. The existing land tenure system in the country may influence agricultural productivity indirectly through its effect on the farm household's decision to invest on RWH technology and use of inputs such as fertilizer and improved seed. Moreover, as can be depicted from the figure, household-level factors could affect

agricultural productivity indirectly through farm household's decision on the use of inputs and adoption of RWH technology.

In sum, the household income and welfare condition affect institutions, household level factors, and plot level factors directly. The productivity of the agricultural sector can be affected by institutional factors, household level factors, and plot level factors and with village level factors directly. And the household income can be affected by the agricultural production.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Socio-Economic Analysis of Sample Households

The total sample households include 88% male-headed and 12% female headed households. In addition the sex composition of households with RWH technology is 98% male-headed and only 2% female headed households. Sample households both in the RWH technology user (94%) and non user (90%) groups were married. Besides, the average family size of farmers in the RWH technology user and non user group is seven and six respectively. This can show us there is no as such big variation between the RWH technology user and non user household family size.

The average age of sample households is 35 with no variation in the RWH user and non user farmers. This indicates relatively more energetic and productive people are included in the sample. And safely those people are not resist change like new technologies since their exposure to information is high.

In the study, sample households who received education and did not get education are included by chance. The educational level of households with the technology is 8% illiterate, 32% read and write, 54% primary, and 6% attend secondary school. While those who are illiterate accounts 22% in the RWH technology non user followed by 40% of the households who can able to read and write, 28% receive primary education, and those who receive secondary education accounts 10%. Significant variation can be observed in the illiteracy level of the total households who are RWH users and non users.

The educational level of the wife and chilled of sample household heads in the RWH technology user and non user groups show significant variation. In the technology non user group only 28% of the wife's of the household head receive education while the wife's of the technology user group household head accounts 40%. Again the educational status of children in the RWH user and non user groups have slight variation. A large number of children (84%) have got education in the RWH technology user. Where as the

total number of children who received education in the RWH technology non user is about 70%.

The table below shows the sex composition, marriage status, and education level of the total sample household heads in the study area.

Table 5.1 HHH sex composition, marriage status and educational level by adoption of RWH

	RWH technology user % (N)	RWH technology non user % (N)	Total % (N)
Sex:			
Male	98 (49)	78 (39)	88(88)
Female	2 (1)	22 (11)	12(12)
Marriage status:			
Married	94 (47)	90 (45)	92(92)
Unmarried	6 (3)	10 (5)	8(8)
Educational level			
Illiterate	8 (4)	22 (11)	15(15)
Read and write	32 (16)	40 (20)	36(36)
Primary	54 (27)	28 (14)	41(41)
Secondary	6 (3)	10 (5)	8(8)

Source: Own survey, 2009

With regard to RWH technology, all the farm households with the technology received information before they get involved. But only 66% of the farm households without the technology got information. Based on this, it is possible to say farm households who have better information before they get involved have high probability to join the technology.

In the study area, farm households have started to use the RWH technology since 2003. And from that time onwards the number of farmers involved in the technology is increasing time to time. Even farm households who adopt the technology by the year 2008 were observed in the technology user group. As shown in the figure below of all the total farm households 50 in the sample most of them adopted the technology in the year 2005-2007, while the rest of the farm households adopted it in the year 2002-2004 and 2008.

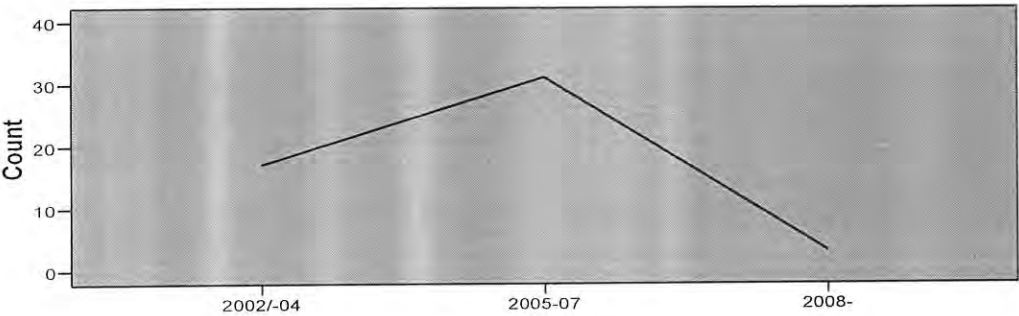


Figure 5.1 Illustrates the time farm households adopt RWH technology in year

The different types of resource endowment which includes livestock, and land resource of farm households in both the technology user and non user groups are mentioned in table 5.2. With regard to asset ownership, significant variations have been observed between the technology user farm households and the technology non user farm households. As can be seen from the table 96% RWH technology user farm households have their own land. On the other hand 82% of farm households in the non user group owned land resource. The large number of farm households in the RWH technology who have their land relatively indicates that there is positive relationship among land ownership of farmers and RWH technology adoption.

In addition to the land holding information of farm households, investigating the variation of the total land size among the RWH user and non user groups are relevant for this study. As shown in table 5.2 below there is no even a single farm household whose land is less than one hectare in RWH user group of farmers. Rather 81.3% of the sample households have one hectare farm land size followed by 16.7% and 2.1% farm households having a total land size of 2 hectare and 3 hectare respectively in this group.

On the contrary, as can be seen from table 5.2 below 56.1% of farm households land size in the RWH non user group of farmers are categorized under a total of one hectare farm land size. But 31.7% and 12.1% of the non user sample households' farm land size lie with in less than one hectare and two hectare category. So the study shows that there is variation among households in the RWH technology user and non user group in terms of land possession and the total size of the land they acquired. In both land possession and total land size the rainwater harvesting technology user farm households have better position as compared to their counter parts. And this can be the reason for their involvement in the RWH technology.

Besides land resource, livestock is the other type of assets especially for farm households who live in the rural area. Like that of the land resource there is also significant variation in terms of the number of livestock among the user and non user group of RWH technology. As can be seen in table 5.2, 50% of the farm households in the RWH user group have livestock that ranges from 6-10, while 28%, 18% and 4% of the sample households possess livestock that ranges from 11-15, 0-5 and 16-20 respectively.

On the other hand, the large number of RWH technology non user farm households(46%) own a total number of livestock that ranges from 0-5. The other non user farm households 42%, 10% and 2% were found to have a total number of livestock that ranges 6-10, 11-15 and 16-20 respectively

Furthermore the most important asset for the farm households in the traditional farming agriculture is the availability of oxen. Similarly, Fekadu (2008) came up with the same type of conclusion that oxen availability is vital for farm households as agriculture depends on traditional farming system and it is also a source of income for the household. The analysis was taken to see whether there is a significant difference in oxen availability between the RWH technology user and non user farm households. As can be seen in table 5.2 below there is significant difference in oxen availability between the two groups of farm households. The large number of farm households (92%) with the technology has oxen. But oxen availability is limited to only 60% of the RWH technology non user

group. The conclusion seems that those households who own oxen are better in the adoption of RWH technology.

Table 5.2 Illustrates household characteristics distribution of land and livestock resources

Types of asset	RAH user	RWH non user	Total
	% (N)	% (N)	% (N)
Land resource:			
Land availability			
Yes	96 (48)	82 (41)	89(89)
No	4 (2)	18 (9)	11(11)
Land size			
< 1 hectare	2 (1)	31.7 (13)	13(13)
1 hectare	79.6 (39)	56.1 (23)	62(62)
2 hectare	16.3 (8)	12.2 (5)	13(13)
> 3 hectare	2 (1)		2 (1)
Livestock:			
Livestock availability			
Yes	100 (50)	45(90)	95(95)
No		5(10)	5(5)
Number of livestock			
0-5	18 (9)	23(46)	32(32)
6-10	50 (25)	21(42)	46(46)
11-15	28 (14)	5(10)	19(19)
16-20	4 (2)	1(2)	3(3)
Oxen availability			
Yes	92 (46)	60 (30)	76(76)
No	8 (4)	40 (20)	24(24)

Source: Own survey, 2009

5.2 Practices of Rainwater Harvesting

For the study a total of 100 farm households classified in to RWH technology user and non user groups were surveyed. Of the total sample households 83% of them have information about RWH. This safely tells us information about rainwater harvesting is better disseminated in the study area. But only few farmers in the area adopted the RWH technology and have started to use for domestic purpose, and for different agricultural activities. The selected farm households responded that the number of non adopters is high; this is due to financial constraint, labor unavailability and lack of detail information to adopt the RWH technology. Similarly, Rami (2003) stated as due to the failure to distribute manual, absence of detail information became a major problem for farm households to adopt RWH technology in Amhara and Tigray region. As can be seen in table 5.3 below 54% of the farm households in the non user group did not adopt due to financial constraint. Where as 44% and 26% of the non user farm households isolate themselves from the technology because of lack of detail information and man power shortage respectively.

Table 5.3 List of problems facing non user sample household to adopt RWH technology

	%(N)
Financial constraints	54(27)
Lack of detail information	44(22)
Man power shortage	26(13)

Source: Own survey, 2009

As can be seen in the table below farm households who engaged in RWH technology use the harvested water for crop production, domestic purpose and for livestock fodder production and drinking. Based on the multiple response of the RWH technology user farm households, majority of the farmers use the stored water for vegetable production 98%, 82% for livestock, 22% for crop production, and 16% of the farm households used for domestic purpose.

Table 5.4 shows purposes of stored water by RWH technology user farm households

	%(N)
Vegetable production	98(49)
For livestock drinking and fodder production	82(41)
Crop production	22(11)
Domestic purposes	16(8)

Source: Own survey, 2009

The responsibility to manage the harvested rainwater is mainly given to the owner of the pond supported by the kebele extension workers and community leaders. According to the multiple responses of sample household farmers in the survey of this study 67% of the respondents said that pond owner farmers are responsible to manage their pond while 46% and 11% of the farm households responded that extension workers and community leaders are responsible respectively.

In the study area the highest responsibility to manage the rainwater harvesting pond is given to the owner of the pond. And it is believed that this could increase their sense of ownership and further increase the pond efficiency.

At the start of the technology there were selections of farmers for RWH pond adoption in the study area. People who were responsible to select the farmers use different criteria to make the technology effective and increase its acceptance. 52% of the farm households responded that there were selections while the rest of the sample farm households responded that there was no selection for the RWH technology adoption. The ambiguity is because there was selection at the introduction of the technology and stopped it after this phase as revealed by KI with the extension workers.

The key informant discussion with the selected farmers revealed that few farmers were developed hatred towards the rainwater harvesting technology and this affect the expansion of the technology negatively. The discussion disclosed that farmers hate the technology due to the partiality done by the responsible body during the selection

process. Later those farmers who need to have rainwater harvesting pond began to involve by their own initiative and the responsibility of the experts were limited to only consulting.

In the study area, even though the responsibility of one is related with the other, farmers were directly selected in collaboration with the woreda bureau of agriculture, kebele extension workers, and kebele officials. The focus group discussion with the selected farm households revealed that the main role in the selection process was played by the kebele officials. And this causes biasness, corruption and inappropriate site selection of pond location. As can be seen in table5.5 below according to the response of 71.2% of the sample households, farmers were selected by kebele officials. And again, 46.2% and 9.6% of the respondents replied that agricultural development agents and the woreda bureau of agriculture are responsible for selection of farmers respectively.

Table 5.5 Responsible body to select farmers for RWH adoption

	% (N)
Kebele officials	71.2 (37)
Extension workers	46.2 (24)
Woreda bureau	9.6 (5)

Source: Own survey, 2009

The major criteria used to select farmers at the beginning of the technology distribution were land suitability to the structure, farmers’ willingness and rainfall pattern of the study area. Out of those households who responded that land suitability, farmers’ willingness and rainfall pattern of the local area, 93.8% said that the willingness of farmer comes in the first place. About 41.7% replied that farmers selection is depend on the rainfall pattern of the local area. Moreover 29.2% of them responded that land suitability to the structure matter the selection process of farmers to the technology.

Taking the willingness of the farmers as a major criterion supports the sustainability of the technology since it increases the farmers’ sense of ownership. However, much

dependency on farmers' willingness can also be a threat for the productivity of the RWH technology. This argument is based on the fact that for the successful implementation of technologies both indigenous and scientific knowledge should be used (Oweis, 2006)

In this study, there are also individuals who adopt RWH technology by their own personal initiative, learn from their neighbors, and because of the advice they got from extension workers. In the three selected kebeles of the study area (i.e. Angewa, Kolomargefia, and Aguatwha) there are a total of 28 farmers who adopt RWH technology by any of the three ways mentioned above.

As shown in table 5.6, 67.9% of these farm households adopt the technology by their personal initiative, while 17.9% and 14.3% farm households adopt the technology through the help of the advice of the extension workers and taking their neighbors as a role model respectively.

Table 5.6 Depicts sample household response by characteristics of the technology adoption

	%(N)
Personal initiative	67.9 (19)
Advice from extension workers	17.9 (5)
Learn from neighbors	14.3 (4)
Total	100(28)

Source: Own survey, 2009

As to Rami (2003) for effective planning and implementation of rainwater harvesting trained man power is important. In the sample household respondents of this study 90% of the farmers who adopted the technology and 24% of the respondents who did not adopt the technology have got training about RWH technology.

In the rainwater harvesting user group, 66.7% of the farm households got training about the purpose of pond. And in this group 52% of the farm households took training about how to dig pond. And the training on how to select pond location accounts 46% of the respondents in the RWH farm households. Further more training like how to cover,

lifting and application of the stored water and how to keep the pond water clean are given for few of the RWH technology user farmers. On the other hand 24% of the respondents in the RWH non user group took similar type of training. The other 76% of the respondents in this group did not get any training. The prevalence of large number of farm households without any training can be taken as a drawback to the fast expansion of the RWH technology. This implies that there should be a need to give training for the mass of the people about RWH technology.

Even though, 66.7% of the respondents who adopt the technology and 24% the non adopters said that they received training; It is only 75.6% the farm households in the user group responded that the training helped them to use the pond water effectively. The remaining 24.4% in the user group and 24% in the non user group replied that they did not benefit from the training. This could probably be due to lack of continuity of the training, and the weakness of the farmers to implement it.

As shown in table 5.7 RWH technology user farmers in the sample adopt the technology with different reasons. Of the total RWH technology user farmers 86% responded that they adopt the technology due to the prevalence of water shortage in the area. About 78% of the respondents adopt the technology because of the pressure came from the development agents. Further, 76% of the respondents responded that they are with the technology since they need to produce more. Where as 4% of the technology user responded that they adopt the technology as a result of sever soil degradation in their locality.

Table 5.7 Factors of adoption of RWH

	%(N)
Water shortage	86(43)
Pressure from DAs	78(39)
To produce more	76(38)
Due to soil degradation	4(2)

Source: Own survey, 2009

Almost all ponds in the study area are made of either from plastic lined or concrete made of cement. From the total RWH user farmers' pond in the sample 40% of them are plastic lined and the other 60% are cement lined ponds. As can be seen in table 5.8 most of the respondents in the sample preferred to have individual pond than pond owned in group which is called communal pond. The focus group discussion with the selected farmers revealed that the desire of farmers to have individual pond are to avoid conflict, competition among members, and to treat the pond better and the need to produce more. On the contrary, those sample households who preferred to have communal pond said that it helps them to share the construction cost, and to share skills and knowledge among members.

Table 5.8 Shows pond preference of sample households

Types of pond	% (N)
Communal pond	26(26)
Individual pond	74 (74)
Total	100 (100)

Source: Own survey, 2009

Most of the technology adopter farmers constructed their pond in cooperation with each other either in the form of labor exchange or as work for food which is financed by FAO, SWHISA, Safety net and the woreda agricultural office. As can be seen in table 5.9, 40% of the ponds are done through WFF program followed by labor exchange among the farmers themselves (24%). And only 20% of the farmers dug their pond with the help of their family labor. The other 16% of the farm households dug their pond personally.

Table 5.9 Depicts RWH user farmers labor source when they dug their pond

	% (N)
With WFF program	40 (20)
Labor exchange	24 (12)
With family labor	20 (10)
Personally	16(8)

Source: Own survey, 2009

5.3 Perception of the Local Community Towards the Limitation and Prospects of Rainwater Harvesting

Both the RWH technology user and non user households were asked to indicate whether the problem of rainfall shortage can be averted by RWH technology or not. And as shown in table 5.10 below 78% of the sample households with the technology responded that it is possible to avert shortage of rainfall by properly harvesting rainwater. But those sample households without the technology only 46% of them replayed the possibility of solving rainfall shortage problem using RWH technology. From this, it is possible to say that even though there is a difference; farmers in the study area in both households with and without the technology have better awareness about the advantage of RWH technology.

Table 5.10 Rainfall shortages can be averted by RWH technology

RWH user	RWH non user	Total
% (N)	% (N)	% (N)
78(39)	46(23)	62(62)

Source: Own survey, 2009

About 90% of sample households both in the technology user and non user groups responded that no disadvantage was observed that come due to RWH technology in the study area. Only 10% of the sample households responded that sometimes sudden livestock life loss when hens, calves and oxen enter into the pond in the absence of fence for the pond. The key informant discussion with the woreda agriculture natural resource department bureau revealed that one farmer had lost his third child in 2008 when the baby was played around and got in to the pond on market days in the absence of his parents.

Most of the farmers both in the technology user and non user sample households argued that RWH technology can support them to become food secured. As shown in table 5.11, 86% of the sample households said that rainwater harvesting can be a solution to food security. This is because rainwater harvesting helps the farmer to produce during dry

season, increase the number of harvesting time per year, and increase yield by supplementing dry spell period.

Table 5.11 Depicts sample household farmers perception to RWH technology as a means of food security

RWH helps HH to	Produce during dry period	Increase harvesting time	Increase yield	Avoid crop failure
% (N)	78.7 (70)	83.1(74)	69.3 (61)	61.8 (55)

Source: Own survey, 2009

On the contrary, the information taken from few of the farmers in the sample shows that due to the prevalence of high evaporation, small amounts of the collected water and the price fluctuation in the market for the goods produced by the RWH technology are the main problems faced the technology to bring the expected food security status of farmers. This idea was supported by the key informant discussion with the coordinators of FAO, and Safety net program. They argued that RWH technology is vital to improve the food security of farmers in areas where there is rainfall variability and short dry spell. But the technology in the study area is challenged by the prevalence of high evaporation mainly due to lack of pond cover. This further contributes for the less amount of water to exist in the pond. And the problem faced the technology to bring food security is further aggravated by market price fluctuation of goods produced by farmers using RWHT. Owing to this farmers became disappointed and sometimes it is common to see dropout of farmers from the technology and use the pond for the accumulation of compost/manure.

Table 5.12 shows the sample household respondents reasons who said that rainwater harvesting technology can not able to bring food security to farmers in the study area.

Table 5.12 Farmers’ reasons about the failure of RWHT to bring food security

	% (N)
High evaporation of pond water	70(7)
Price fluctuation of goods	30(3)
Less amount of stored water	90 (9)

Source: Own survey, 2009

Farmers especially at the beginning of the introduction of new technology should be supported by the government and other developmental organizations. About 72% and 76% of the farmers in the sample of RWHT non users and users respectively responded that the assistance given to farmers to use RWHT from the government and non governmental organizations are not enough.

However, most of the farmers in the sample responded that the support from the government and non governmental organizations help them to be self-reliant.

This is probably due to the use of the aid for the investment of RWH technology expansion which further has a potential to increase agricultural yield. About 64% of the RWH technology non user and 72% of the technology user farmers responded that the assistance for the expansion of the technology helps the farmers to be self sufficient.

The slight difference may be due to the fact that farmers with the technology practically saw the importance of the aid to assure self reliance. About 68% of the farmers in the total sample household responded that the assistance from the government and other developmental organizations help them to be self reliant.

Farmers with the RWH technology was assumed to have better understanding about the importance of cost sharing for the quality implementation of the technology. But as opposed to this both the technology user and non user farmers know the importance of cost sharing for the better implementation of RWHT. This may be due to the fact that the multiple effort of the kebele extension workers and the woreda agricultural office in creating awareness.

About 70% of the farmers without the technology and 68% of the farmers with the technology said that cost sharing can increase the efficiency of the technology.

On the other hand, all the sample households were asked to indicate the most effective section of the society for the implementation of RWH technology especially after the construction of the pond. And 49% responded that both women and men can be effective implementers of the technology. In addition 28% of the farmers in the sample responded that men are more effective than women since this part of the society is energetic. While the rest 23% of the farmers responded that since the pond is near to the home of the farmer as a result of their daily contact for watering and planting vegetables women are more effective than men.

Therefore, based on the fact mentioned above both men and women can be effective implementers of the technology.

Farmers were asked to indicate whether expansion of RWH pond brought land shortage or not. And 82% of the farmers in both group said that expansion of RWHT does not bring land shortage. But 18% of the sample household farmers in both RWH technology user and non user groups responded that expansion of RWHT can cause land shortage. The majority of the farmers responded that pond expansion can not bring land shortage as compared to the land size of the pond and its benefit. The key informant interview with the selected households revealed that the benefit of the pond is by far greater than the land taken for pond construction. Where as farmers who said that land shortage can be caused by pond expansion reason out that in the presence of fragmented land it is true that pond construction further narrows down the farmers land size. This idea could probably be one reason for the large number of RWHT non user farmers in the study area.

5.4 Factors Affecting Household Decision to Adopt Rainwater

Harvesting Ponds

5.4.1 Land Ownership

As stated in Gezahegn et al, (2006) even though it is difficult to identify the specific cost of RWHT land is required for the construction of the technology as well as for the production of agricultural out put by the stored water. In line with this fact, the land resource of both the technology user and non user group in the study area were investigated and 98% of them own land.

In addition farm households both in the RWHT user and non user group were asked to mention the total land size they owned assuming that total land size and RWHT adoption may have significant association. As can be seen in table 5.13 the total land size of farm households who adopt the technology is greater than the total land size of non adopters. Thus this shows that households who have better land size are more likely to be in the technology than those who have small land size.

Table 5.13 Land size of farmers by status of RWHT adoption

Total land size	RWHT users % (N)	RWHT non users % (N)
< 1 hectare	2(1)	31.7 (13)
1 hectare	79.6 (39)	56.1 (23)
2 hectare	16.4 (8)	12.2 (5)
> 2 hectare	2 (1)	
Total	100 (49)	100 (41)

Source: Own survey, 2009

As can be seen in table 5.14 the Pearson χ^2 -square test of association shows that there is statistically significant association between the total farm land size of farmers and RWHT adoption.

Table 5.14 Pearson χ^2 association between total land size and RWHT adoption

			Farmers in RWHT		Pearson χ^2	P-value	r
			Yes	no	15.519	0.001***	0.415
Total land size of sample HH	<1hectar 1 hectare 2 hectare >3hectare		1	13			
			39	23			
			8	5			
			1	0			
Total			49	41			

*** Significant at 1% *Source:* Own survey and computation, 2009

The Pearson χ^2 value depicts that as the total land size of the farmer increases, the probability of farmers to adopt RWHT can also increase. But the r-value discloses that the association of total land size and RWHT adoption is weak. This is probably due to the large number of farmers with better land size in the RWHT non user group. Individuals in the sample household who do not have their own land cultivate crops either in share or renting of land. Most of these individual farmers (81.8%) are non technology adopters. And the rest 18.2% of them are technology user farmers. This shows that those individuals who do not have their own land do not want to invest on rainwater harvesting technology. Only two individuals who do not have their own land adopt RWH technology in Angewa kebele. The key informant interview with the kebele officials revealed that these two individuals are involved in the technology because they are hard worker and share land with their neighbors who have land around their home.

5.4.2 Land tenure Security and RWH

As stated in Fekadu, (2008) tenure security can encourage farmers to build long lasting investment like RWH, which in turn supplement farmers’ food security status. The total number of sample households who feel tenure insecurity are 6(12%) in the RWH technology user as compared to the total number of farm households 9(18%) who feel tenure insecurity in the RWH technology non user group. On the other hand 82% of the RWHT non user farmers and 88% of the technology user farmers are secured. According to the KI interview with the kebele officials, farmers’ tenure security in the study area is further strengthened by the land certification of the government.

As can be depicted in table 5.15 the Pearson χ^2 -square test of association shows that there is no statistically significant association between tenure security of farmers and RWHT adoption. This is because most of the farmers in the study area have tenure security and few but almost equal numbers of farmers in both groups feel tenure insecurity.

Table 5.15 Pearson χ^2 association between tenure security and RWHT adoption

		Farmers in RWH		Pearson χ^2	P-value	r
		Yes	no	0.706	0.288	0.084
Tenure security	yes	44	41			
	no	6	9			
Total		50	50			

Source: Own survey and computation, 2009

5.4.3 Plot Distance and Rainwater Harvesting

As to Rebeka (2006) Farmers prefer to invest on RWHT most of the time in and around their homestead plot. As can be seen in table 5.16, 76% of the RWHT user farmers responded that the distance between their home and the nearest plot they acquired took less than an hour.

While the other (24%) of farmers with the technology responded that their nearest plot took an hour travel on foot from their home.

On the contrary, the non user farmers plot distance is a little bit far from their home and this can be one reason for the farmers not to adopt the rainwater harvesting technology. As can be depicted in table 5.16, 46% of the farm households in this group responded that the nearest plot they acquired took less than an hour to travel from their home. In addition, 30% and 18% replied that they should travel an hour and two hours from their home to the nearest plot they acquired.

Table 5.16 Depict farmers travel time in hours from home to their nearest plot acquired

Nearest HH plot distance	RWHT user farmers % (N)	RWHT non user farmers % (N)
Took < 1hr	77.5 (38)	56 (23)
Took 1 hr	22.5 (11)	22 (9)
Took 2 hrs		22 (9)
Total	100 (49)	100 (41)

Source: Own survey, 2009

The Pearson χ^2 -square test of association in table 5.17 shows that the associations between the nearest plots distance from farmers home and RWHT adoption is statistically significant.

Table 5.17 Pearson- χ^2 association between farmers plot distance (hr) and RWHT adoption

Nearest HH plot distance from farmers' home	Farmers in RWHT		Pearson χ^2	P-value	r
	Yes	no			
HH plot distance yes	38	23	9.458	0.002***	0.308
took less than an hour	12	27			
HH plot distance yes	12	15	0.457	0.499	-0.068
took an hour	38	35			
HH plot distance yes	0	9	9.89	0.002	-0.314
took two hrs	50	41			

*** Significant at 1%

Source: own survey, 2009

The Pearson χ^2 value depicts that those farmers which have plot around their home have high probability to adopt rainwater harvesting technology. As can be seen in table 5.17 above as the time taken to travel to the nearest plot of farmers took longer hours from their home, farmers may not adopt the technology at all. But the intensity of the association is weak (0.308) due to the fact that there are farmers who did not adopt the RWHT in the sample who have plot around their home.

The Pearson χ^2 result further consolidated by the focus group discussion both with the selected participant and non participant farmers. They revealed that if the distance from their home to the plot is long, farmers become discouraged to fully utilize the harvested water. They reason out that the long distance can affect the day to day contact of family members to utilize the harvested water efficiently. This further became a cause for the lack of interest of the farm household to invest on the RWHT. Lastly the farmers mentioned their suspicion that if their pond is far from their home other farmers without getting permission from the owner can use it.

5.4.4 Educational Status of HHH and RWH

Fekadu (2008) stated that education is the most important tool to understand and implement new technologies like RWH. As a result, an educated HH is assumed to be better adopter of rainwater harvesting pond.

As shown in table 5.18 more than half of the sample household respondents are educated both in the RWH technology user and non user farm households. But the educational level of farmers with RWH technology is better as compared to the educational level of RWH non user farm households.

Table 5.18 Educational level of HHH by the status of RWH

	RWH non user	RWH user
	% (N)	% (N)
Illiterate	22 (11)	8 (4)
Read and write	40 (20)	32 (16)
Primary	28 (14)	54 (27)
Secondary	10 (5)	6 (3)
Total	100 (50)	100 (50)

The Pearson χ^2 test of association shows that there is a significant association between the educational level of the HHH and the RWH adoption status of households as can be seen in table 5.19

Table 5.19 Pearson χ^2 test association of educational level of HHH and RWH adoption

		Farmers in RWH		Pearson		
		Yes	no	χ^2	P-value	r
Educational level of household head	Illiterate	4	11	8.333	0.04**	0.289
	Read and write	16	20			
	Primary	27	14			
	Secondary	3	5			
Total		50	50			

** Significant at 5% *Source:* Own survey, 2009

The analysis was done in order to see whether there is statically significant association between HHH educational level and adoption of RWH technology. The Pearson χ^2 table showed that there is statistically significant association at 5% level. This means as the level of education of the farmer increase, the probability of the farmer to adopt RWH

technology can also increase. However, the fact that there are large number of educated farm households in the RWHT non user group weaken the intensity of the association (0.289)

5.4.5 Livestock Availability, Number of Livestock and RWH

The availability of livestock is vital for the agricultural economic sector since the sector highly depends on traditional farming system. About 95% of the farmers both in the RWHT user and non user group have their own cattle. This study came up with only 10% of the RWH non user farmers are without cattle. In addition, the total number of livestock as mentioned in table 5.2 between the RWHT user and non user group has significant difference.

As shown in table 5.20 the Pearson χ^2 -test of association depicts that there is statistically significant association between availability of livestock and RWHT adoption.

Table 5.20 Pearson χ^2 -test of association between livestock availability and RWH

		Farmers in RAH		Pearson χ^2	P-value	r
		Yes	No	5.263	0.022**	0.229
Livestock availability	yes	50	45			
	no	0	5			
Total		50	50			

** Significant at 5% Source: Own survey, 2009

The intensity of the association between livestock availability and RWH is weak (0.229) due to the high number of farmers who have livestock in the RWH non user group.

In addition, as shown in table 5.2 farmers who are in the technology user group have better number of livestock as compared to their counter part. The Pearson χ^2 -test of association portrays that there is statistically significant association between total number of livestock and RWHT adoption. The association result is presented in table 5.21 as follows.

Table 5.21 Pearson χ^2 -test of association between number of livestock and RWH

		Farmers in RAH		Pearson χ^2	P-value	r
		Yes	No			
Number of livestock available				11.069	0.011**	0.333
	0-5	9	23			
	6-10	25	21			
	11-15	14	5			
	16-20	2	1			
Total		50	50			

**significant at 5% *Source:* Own survey, 2009

From this it is possible to say that farmers who have large number of livestock are in good position to adopt the technology. But, even though there is statistically significant association between the total numbers of livestock and RWH technology, the intensity of the association is weak (0.333).This is because the presence of RWH non user farmers having better number of livestock.

5.4.5.1 Oxen Availability and RWH

From the total households in the sample 92% RWH technology user farmers and 60% of the RWH technology non user farmers have oxen as illustrated in table 5.2

As indicated in table 5.22 below, oxen availability and RWH have statistically significant association at 1%.This means farmers who have their own oxen have high probability to adopt RWH technology.

Table 5.22 Pearson χ^2 association between oxen availability and RWH

				Pearson		
		Farmers in RWHT		χ^2	P-value	r
		Yes	No	12.705	0.00	0.356
Oxen availability	yes	46	31			
	no	4	19			
Total		50	50			

Source: Own survey, 2009

The relative difference among the user and non user group support the idea that oxen availability and the adoption of RWH technology are interrelated. This means farmers who have their own oxen have high probability to adopt the technology. But the presence of farm households with oxen and without the technology made the intensity of the association weak (0.356).

5.4.6 Credit Service and RWH

Access to credit service helps the farmer to adopt new technologies like RWH which has future hope to improve agricultural products. Credit is assumed to be important for farmers in order to construct ponds, improve the pond quality, to scale up the size of the structure. Further the improvement of the structure helps to sustain the technology and maintain water availability during dry season (Rebeka, 2006).

As can be seen in table 5.23, 68% of the RWHT user farmers in the sample are credit service user. In addition, 42.2% of the RWHT non user group of farmers is also credit service user. In general 83% of the total sample households have access to credit service and the service is provided by private credit association (5.9%) the government (45.3%), and with bilateral organizations like FAO and safety net (45.1%).

Table 5.23 Farmers obtained credit by the status of RWH

RWH users	RWH non	Total
% (N)	users	% (N)
	% (N)	
68 (34)	42.2 (19)	55.8 (53)

Source: Own survey, 2009

Out of the total sample households only 55.8% of them took credit and the rest 44.2% did not obtain credit due to different reasons. The major reasons mentioned by both the technology user and non user group of farmers in the sample were afraid of debt (43.2%),inability to repay back previous credit(20%),and insufficient supply of credit (21.7%).

In addition the key informant interview with the selected household revealed that the highest interest rate, lack of collateral, absence of credit service associations are the reasons for farmers not to take credit.

Among those farmers who took credit only 57.9% of the non users and 64.7% of the technology user farmers received the amount of money they need.

Most of the farmers in the sample took credit to purchase agricultural inputs such as improved seeds, and fertilizer, to adopt technologies like RWH, to fulfill their basic needs including food. As can be seen in table 5.24 there is variation among the RWH technology user and non user farmers in terms of the purpose of credit.

Table 5.24 purpose of credit by farmers RWH status

	RWH user group	RWH non user group
	% (N)	% (N)
To buy agricultural inputs	88.2 (30)	57.1 (8)
To buy food	2.9 (1)	35.7 (5)
To construct RWH pond	2.9 (1)	
For multiple purpose	20.6 (7)	21.4 (3)

Source: own survey, 2009

The Pearson χ^2 association indicated that there is statistically significant association between RWHT adoption and credit obtained.

Table 5.25 Pearson χ^2 association between credit obtained and RWHT adoption

		Farmers in RWHT		Pearson χ^2	P-value	r
obtained credit	yes	Yes	No	6.381	0.012**	0.259
		34	19			
	no	16	26			
Total		50	45			

**Significant at 5%

Source: Own survey, 2009

From the table it can be possible to argue that there is statistically significant association between credits obtained and RWHT adoption at 5% level of significant. But the existence of non RWHT user farmers who obtained credit made the intensity of the association weak (0.259).

5.4.7 Saving and RWH

Saving and investment have direct relationship (Desta, 2004). This means as the saving habit of an individual increase, his potential to invest on newly productive technology can also increase.

As shown in table 5.26 below 68% of the total number of farmer in the RWH user and 30% of RWH non user group save their money in different way. In relative terms the difference implies that farmers with the technology have developed better saving habit and this may create favorable condition for them to adopt RWH technology.

Individual farmers who did not participate in saving mentioned that shortages of money (92.6%), failure to know the advantage of saving (7.7%) are the two main reasons which became obstacle for them to save.

Table 5.26 Farmers saving habit by RWH status

	RWH user	RWH non user	Total
	% (N)	% (N)	% (N)
	68 (34)	30 (15)	49(49)

Source: Own survey, 2009

On the contrary, individuals who know the advantage of saving put their money either in cash or in kind. They save their money in the bank, being a member of ikub, in their home in cash form and in kind by buying livestock. The Pearson χ^2 test as can be seen in table 5.27 indicates that saving and RWH technology have statistically significant relationship. This means the participation of farmers in saving increase their possibility to adopt RWH technology. The intensity of the association is weak (0.380) in that there are also farmers who adopt RWH technology with no saving experience.

Table 5.27 Pearson χ^2 test of saving and RWHT adoption

		Farmers in RWH		Pearson χ^2	P-value	r
		yes	No			
Farmers saving habit	yes	34	15	14.446	0.000***	0.380
	no	16	35			
Total		50	50			

***Significant at 1%

Source: Own survey, 2009

5.4.8 Use of Fertilizer and RWH

Farmers who are better in using artificial fertilizer are assumed to be good adopters of rainwater harvesting technology. This is due to the fact that individuals who have better income and who need to produce more agricultural products use artificial fertilizer keeping other things constant and relatively they can be also better adopter of the technology. The Pearson χ^2 test was employed to see the association of fertilizer and RWH technology adoption. As can be seen in table 5.28 artificial fertilizer and RWH technology adoption have statistically significant association at 5%. This means the probability of artificial fertilizer user farmer to adopt RWH technology is relatively high as compared to their counter part. But in this study the intensity of the association is weak (0.231) due to the large number of farmers in the sample who apply chemical fertilizer but without RWHT.

Table 5.28 Pearson χ^2 -test of association between artificial fertilizer application and RWH adoption

		Farmers in RWH		Pearson χ^2	P-value	r
		Yes	No			
Chemical fertilizer user farmers	yes	38	27	5.319	0.021**	0.231
	no	12	23			
Total		50	50			

**significant at 5%

Source: own survey, 2009

Farmers who did not use chemical fertilizers mentioned different reasons. The major reasons mentioned during the key informant discussion with the selected households were the difficulty to afford the price of the fertilizer, and shortage of fertilizer supply at the critical time. And again, few households said that they prefer to use compost/manure instead of chemical fertilizer. About, 35% of the sample households are not artificial fertilizer user. Out of the total sample households who did not use chemical fertilizer 80% of them responded that they could not able to afford the price while the rest is due to insufficient supply, and use of manure as substitution. Surprisingly all the non user of chemical fertilizer did not respond absence of soil fertility as a reason for their dropout to use chemical fertilizer. This can be due to the historical degradation of the area (Ayalew, 2003)

On the other hand, with the same reason given to chemical fertilizer, households who use manure/compost are assumed to be better RWHT technology adopters. In this research 88% of the RWHT user and 70% of the RWHT non user farmers responded that they are manure/compost users. As shown in table 5.29 Pearson χ^2 -test was employed to check whether use of manure can be one determinant factor for RWHT adoption of farmers in the study area. The computed Pearson χ^2 value indicates that use of manure and RWHT have statistically significant association as 5% level. Despite of the association between use of manure and RWHT adoption the strength of the relationship is weak since the sample include many farmers who use manure and who did not adopt the technology.

Table 5.29 Pearson χ^2 -test of association between use of manure and RWHT adoption

		Farmers in RWHT		Pearson χ^2	P-value	r
		Yes	No	4.882	0.027**	0.221
Manure users	yes	44	35			
	no	6	15			
Total		50	50			

**significant at 5% *Source:* Own survey, 2009

5.4.9 Sources of HH Income and RWHT

In the study area farmers got income from on-farm activities, off-farm activities and from remittance as well. As can be seen in table 5.30 all the farmers in the sample both RWHT user and non user groups participate in on-farm activities. While the participation of RWHT user farmers in the off-farm activities are less than the RWHT non user farmers. Further more almost equal number of farm households in the RWHT user and non user group earned income from remittance. In table 5.30, the total percentage of households who earned income from off-farm activities 52%.But the total percentage of farmers who got income from off-farm activities in the RWHT non user group is 78%.Again,households who got income from remittance is 12% and 10% in the non user and user groups respectively.

Table 5.30 Sample households source of income by RWH status

	RWHT users % (N)	RWHT non users % (N)	Total % (N)
On-farm activities	100 (50)	100 (50)	100(100)
Off-farm activities	52 (26)	78 (39)	65 (65)
Remittance	10 (5)	14 (7)	12(12)

Source: Own survey, 2009

In order to see the association of each income sources of farmers with RWHT adoption Pearson χ^2 -test was employed. Since all the farmers in both RWHT user and non user group engaged in on farm activities the Pearson χ^2 can not be computed. Again, as shown in table 5.31 the Pearson χ^2 test is statistically not significant between incomes from remittance and RWH adoption. While the Pearson χ^2 test between off-farm income sources and RWH adoption indicates that they have statistically significant negative association. This means as the income of the farmer from off-farm activities increase, the probability of the farmer to adopt RWHT decrease. This is because when farmers got

better amount of income from off-farm activities there need to improve the agricultural sector go down and sometimes they left the sector (Tesfaye, 2005). The numbers of farmers who participate in off-farm activities are large. This is because; the agriculture sector is discouraging due to historical degradation of the area.

Table 5.31 Pearson χ^2 -test of association between off-farm sources of income and RWH adoption

			Pearso		
			n χ^2	P-value	r
Farmers in RWH			7.429	0.006***	-0.273
Yes No					
Earn income from off-farm activities	yes	26 39			
	no	24 11			
Total			50 50		

*** Significant at 1% *Source:* Own survey, 2009

5.4.10 Labor Availability and RWH

In order to utilize and implement, RWHT needs labor power both at the construction phase and after the construction of the pond. It needs labor during the pond construction to dig the whole, to concretize the pond, to make cover and to fence it. While after the construction of the pond labor is needed to prepare the land, planting crops and vegetables, watering them and harvesting the product. It is believed that households who have better number of independent family labor have the possibility of adopting RWH technology. The key informant interview with the selected sample households in the rainwater harvesting user revealed that labor unavailability is a major challenge to utilize and implement RWHT in the study area. They also said that majority of the ponds are constructed with the support of government bilateral organizations which include FAO, SWHISA, and Safety net program. Based on further discussion, people including the owner of the pond are hired by these organizations in the name of work for food program (WFF).

Lastly, the key informant interview with these people assured that only few people adopted the RWHT by themselves. Even sometimes farmers who have constructed pond by WFF program drop out from the technology due to labor unavailability to utilize the harvested water. As shown in table 5.32 the total family size of the sample households both in the RWH user and non user groups mainly ranges from 4-7 people in one family on average. Out of which 2-4 people are dependent either due to the presence of young children or aged people. And farmers who engaged in RWH technology have relatively large number of family as compared to those farmers who are not technology user. About 86% of the total family sizes of the RWHT user farmers lie with in the range of 4-7 people.

Table 5.32 Respondents' total family size by RWHT status

Family size category	RWHT user % (N)	RWHT non user % (N)
0-3	6 (3)	24 (12)
4-7	86 (43)	74 (37)
8-11	4(8)	2 (1)

Source: Own survey, 2009

As can be seen in table 5.33 the Pearson χ^2 -square test of association shows that there is statistically significant association between the total family size of farmers and RWHT adoption.

Table 5.33 Pearson χ^2 test of association between farmers' family size and RWH adoption

		Farmers in RWH		Pearson χ^2	P-value	r
		Yes	No			
Family size	0-3	3	12	7.650	0.022**	0.277
	4-7	43	37			
	8-11	4	1			
Total		50	50			

**significant at 5%

Source: Own survey, 2009

From table 5.33 as shown above if the total family size of the farmers increase, the probability of the farmer to adopt RWHT can also increase. This is due to the fact that as the total family size increase, the possibility of the farmers to get labor within the family can also increase. The intensity of the association (0.277) is weak in that there are farmers in the sample having large number of family size but without the adoption of the technology. Farmers who responded that their family size is not enough for RWHT operations prefer to use different mechanisms to get additional labor. About 67.6% of the RWHT user farmers responded that their means to get labor is through exchange (Wonfel in the local language). And 26.5% of them responded that they hired workers and lastly 11.8% responded that they use relatives other than their family.

The fact that RWHT needs more labor can be proved by comparing the response of sample household farmers whether the trend of their labor consumption is increasing, decreasing or no change at all. In the RWHT user group 72% of the sample farm household responded that the trend of their labor consumption is increasing. This is because they have begun to produce more than one times in a year by using the stored water.

In the RWHT non user group, the labor consumption of most of the farmers did not show any change. About 70% of the RWHT non user farmers replied that no change is observed in the trend of their labor consumption.

5.5 Challenges of Rainwater Harvesting

On the basis of the key informant interview with the selected RWHT user farmers, the extension workers, and with the woreda agriculture natural resource department bureau rainwater harvesting challenges in the study area are classified into four categories. These are problems related with the technology, environmental related problems, institutional problems, and the problems of the adopters themselves.

5.5.1 Technology Related Challenges

In the study area, the major challenges that are related to the structure/technology/ are the cracking of concrete pond, absence of roof cover design, accidents on animals and kids

and most of the structure lack de-siltation system. As a result most of the ponds found in the study area hold small amount of water due to evaporation, percolation of water to the ground and sometimes the pond totally collapse since it is field with silt during the time of heavy rain as revealed by the extension workers of each kebele.

5.5.2 Institutional and Farmer Related Problems

Since the package of RWHT is a recent phenomenon in its modern concept; lack of trained manpower, inability of the expertise to understand the technology, lack of administrative coordination, lack of equipment to make canal for runoff, lack of water lifting equipment, absence of continuous and organized training or education on how to use and expand the technology in addition to lack of provision of improved seeds are the major institutional challenges that made the technology unsuccessful. Furthermore, the technology is challenged by problems like lack of labor, financial constrains and the feeling of over dependency and carelessness of farmers.

The other institutional problem is the inability to provide materials and improved seeds for the farmers in the study area. As shown in figure 5.2 one farmer in kolomargefia kebele due to lack of appropriate water lifting material use Jurikan to withdraw the water from the pond and take it to his homestead plot where his vegetable is found.

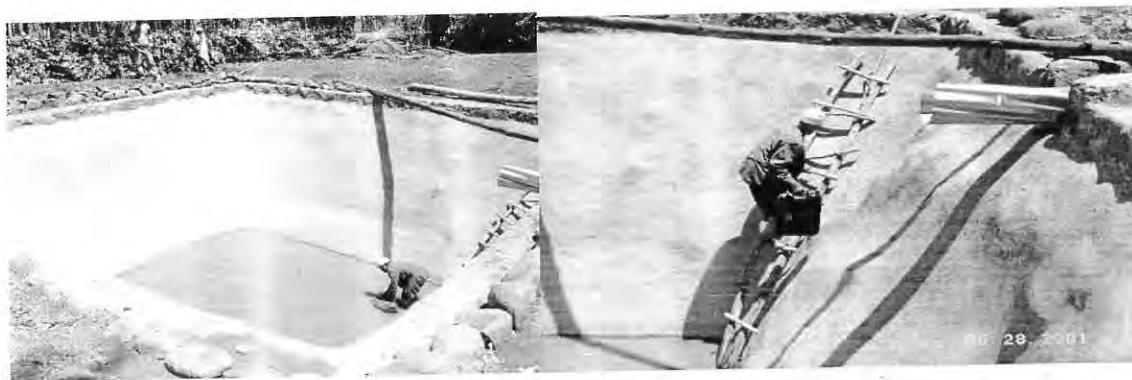


Figure 5.2 Farmers Fetching water from his pond and traveling on the ladder to take the water to his vegetable area with Jurikan in Kolomargefia.

This farmer use a ladder made of wood to come and back to the pond in order to fetch water. At the end, the farmer explained that producing vegetables using jurikan to

withdraw pond water is unthinkable for him in the future. The farmer mentioned that the system is tiresome, time consuming, and threatening the life of the user since the load of the water in the jurikan in addition to his weight is unbalanced with the strength of the ladder.

As can be seen in table 5.34, 74% of the farm households with the technology replied that distance between the farm and the pond is the other main problem of the farmers. In addition 44% of the farmers in the technology user group responded that lack of well organized training as the major problem that can be mentioned. Moreover about 26% of the RWH user group mentioned the problem of lack of water lifting equipment like pedal pump and plastic cannel are the other major challenge stated.

Table 5.34 Major institutional challenges of RWH as weighted by user farmers' response

List of challenges	% (N)
Inappropriate location	74 (37)
Lack of training	44 (22)
Lack of appropriate water lifting	26 (13)

Source: Own survey, 2009

The further discussion mainly with the extension workers of the three kebele disclosed that lack of fence for the pond, lack of pond cover, and wrong pond site selection, are also challenges of farm households 'to be productive in the technology. About 60% of the farmers do not have any cover for their pond. This may be either due to the carelessness or financial constraints of the farmers. And also the key informant discussion with the coordinators of FAO, Safety net and SWHISA revealed that farmers in the study area in particular and in the woreda in general are highly over dependent. They said "if you help them to construct the pond, again they are waiting you to fence and cover" Absence of pond cover may result in excessive evaporation and can be a cause for the failure of the technology. The researcher observed that ponds with cover hold better amount of water as compared to those ponds that are without cover. It is presented in figure 5.3 below that wood and long grasses are the common materials used for all the ponds which have cover.



Figure 5.3 farmer's pond covered with grass in Angewa kebele

Plant leaf are also used by only few farmers to cover their pond and this became create problem. This is because the dried leaf began to accumulate with in the pond and minimize the water holding capacity of the pond, makes the water dirty, and causes bad odour, which further affect the health of the farmers. Figure 5.4 illustrates one farmer pond in Angewa kebele which was once covered by plant leaf. The figure shows the remnants of the dried leaf on the surface of the pond water.



Figure 5, 4 A plastic pond once covered by plant leaf in Angewa

About 66% of the respondent farmers replied that they fenced their pond and the rest 34% of the household responded that their pond was not fenced. This might result in lots of problems like accident on animals and kids. The problem was observed in Angewa kebele of the woreda. The materials used to fence the pond are rope, wood and stone together. In the study area, the total numbers of ponds which have fence are greater than the total number of ponds which have cover. This may probably due to the fear of farmers not to loss their livestock or their kids. So, from this it is possible to understand that RWH ponds are begun to be considered as a problem. And farmers are more sensitive to the negative out come of the pond and this can also limit the expansion of the technology.

In the woreda, the sources of runoff to the household pond are mainly classified into four basic categories. These are runoff sources from small external catchments, from the farm, upstream catchments and direct rainfall. As shown in table 5.35 RWH technology user farmers responded that they mainly got water from direct rainfall (96%). And also about 78% of the households responded that they received water from small external catchments which includes roads, and roof tops. In addition 28% of the households replied that they got runoff from upstream catchments and lastly 4% of the farm households responded that they received runoff from the farm.

Table 5.35 Source of runoff for ponds

Sources of runoff	% (N)
Direct rainfall	96 (48)
Small external catchments	78(39)
upstream catchments	28 (14)
Farm runoff	4 (2)

Source: Own survey, 2009

The key informant interview with the woreda agriculture natural resource department bureau revealed that due to shortage of skilled local planners wrong pond site selection can also be a cause for the failure of the technology. Due to the non conformity of the pond site with runoff catchments and the poor quality of the pond most of the ponds remains to be either empty or only little amount of water they hold. Even though they lack technical skills and experience the planning process of RWH technology including pond site selection was done by local planners (agricultural experts). And 86% of the total sample households responded that the RWH technology expansion is done by local planners available.

Since 2003 onwards the number of RWH ponds is increasing in each of the three kebeles. And this can be an evidence for the acceptance of the technology by farmers in the study area. The idea is supported by the researcher personal observation and the response of the sample household farmers. Of the total sample households, 53% of them feel that the number of ponds is increasing time to time.

However, the key informant interview with the selected farmers revealed that due to institutional problems and problems from the farmer themselves the quality of the pond in the study area is poor especially ponds which were built at the beginning of the introduction of the technology. Many reasons were mentioned for the poor quality of the pond in the study area. But the main reasons based on the result of the key informant interview with the selected farmers were the corrupt activity of officials both at the

woreda and kebele level, lack of skillful and trained manpower in the field of pond construction, lack of administrative coordination, and financial shortage.

Furthermore, 76% of RWH user farmers responded that the pond they adopted are poor in quality. The key informant interview with the DA's disclosed that the poor quality of the pond further became a cause for wastage of resources. For instance, ponds constructed with geomembrane plastic during the first phase are gradually changed into concrete ponds with out giving any service due to leakage in some area. This phenomenon was common in Angewa kebele where the technology have been started in the history of the woreda.

As illustrated in table 5.36, 89.5% of the sample household farmers responded that lack of well trained individual is the reason for poor quality of the pond in addition to the factors mentioned above with the key informant interview. And again 76% of them responded that, financial constraints can also contribute for the poor quality of the pond. Lastly, 2.6% of the respondents responded that quota system expansion has also its own share for the poor quality of the pond.

Table 5.36 Reasons mentioned by sample household farmers about the poor quality of the ponds

Reasons	% (N)
Lack of skilled labor	89.5 (68)
Financial constraints	76 (57)
Quota system pond expansion	2.6 (2)

Source: Own survey, 2009

Related with the technology, there are also challenging situation with regard to agricultural input. As to Gezahegn,et al (2006) in high land areas where moisture is a problem, diversified vegetable production is the most profitable activity with pond technology. But the most common and prominent challenges in the study area as revealed by the selected farmers during the field survey were insufficient supply of improved

seeds having different variety, delay to provide the seeds, the high price of seeds for the most commercial cash crops and artificial fertilizers which became difficult for the farmers to afford by themselves.

5.5.3 Environment Related Pond Problems

The key informant interview with the extension workers disclosed that the soil depth in the study area is very shallow due to the historical cultivation of the area and mismanagement of the environment. As a result the moisture holding capacity of the soil is very poor and needs continuous watering for better production. And they further argued that this also bring a growing interest to harvest run-off and use it when dry spell prevails.

In the study area the soil type ranges from black to clay type of soil. Further discussion with the agricultural extension workers disclosed that clay soil is suitable to the pond structure durability in the study area. But black soil since it expands after rains and contracts and cracks during dry seasons became a cause for cracking of the pond structure and start leaking (Rami, 2003). This is the major reason for farmers in Angewa kebele to shift the purpose of the pond from RWH to compost accumulation and preparation as shown in figure 5.5



Figure 5.5 Farmer's pond once covered by geomembrane plastic and now used for compost preparation



Figure 5.6 Failed farmer's concrete pond due to slope factor.

Again the discussion with the extension workers and the researcher personal observation revealed that the land slop of the study area ranges from steep to gentle slope type. As Rebeka (2006) stated that medium slope is preferred for the RWH technology. The other points mentioned by Malesu et al (2007) is if the land slope is steep the probability of the storage pond to be field by

silt during rainy season is high. Thus such slope type is not recommended for RWH technology. And the same author argued that gentle slope is not also recommended for pond location due to run-off shortage unless the source of run-off should be roof tops. The agricultural development agents further said that some farmers did not adopt the technology because of the nature of their plot slope. From this the researcher reasonably can conclude that land slope and soil type are the main environmental challenges of RWH technology. For instance in Kolomargefia kebel the researcher observed one concrete farmer pond constructed on gentle land slope and which became empty after the rainy season has gone as shown in figure 5.6

5.6 The Role of RWH Technology to Food Security of Households

Out of the total sample households surveyed 53% of them are food secured, of which 66% of the farmers are from the RWH technology user followed by 40% in the non participant households. This means RWH technology user farmers are relatively better food secured. This is because in the participant sample households there are additional 26% households as compared to the non participant households.

Rainwater harvesting technology user farmers were asked whether they obtained additional income or not due to their involvement in the technology and 90% of them responded that they obtained additional income because of their involvement in the technology. Again, the key informant interview with the selected farm households revealed that RWH technology users earn 2000-3000 Ethiopian birr on average yearly. From this it is possible to say that the extra number of farmers in the participant group can be one indicator for the positive contribution of the technology towards food security. In the study area, agriculture is the basic source of income like the other part of the country. Agricultural income in the study area based on the field survey can be divided into three categories. These are income from assets; rain fed agricultural income and income from vegetables and fruits produced by the stored water. The technology of RWH has great potential to improve these three types of agricultural income.

5.6.1 RWH and Rain Fed Agricultural Income

The key informant interview with the kebele officials and with the woreda agriculture and natural resource department bureau witnessed that farmers with the technology obtained significant amount of additional income from selling cash crops such as appeal, pepper, cabbage, and onions etc as compared to the non participant farmers. And the additional income from cash crop selling helps the farmer to buy agricultural inputs which include improved seed, fertilizer and pesticides. Further the use of better agricultural inputs improves the production of the sector and this can help the farmer to be food secured.

On the other hand, the key informant interview with the kebele officials, the woreda agriculture and natural resource department bureau, and the selected RWH participant households revealed that rainwater harvesting non participant farmers do not have this chance to improve their rain fed agriculture. Figure 5.7 below illustrates the production of



appeal, and cabbage produced by the farmer in Angewa using the stored water from his plastic lined pond.

Figure 5.7 irrigated appeal and cabbage produced for consumption and sale in Angewa using plastic lined pond

5.6.2 Rainwater Harvesting and Income from Assets

The harvested rainwater in the study area is also used for livestock drinking and for production of fodder. This further improves the quality of the livestock and increases their selling value and their production as well. In addition the stored water have been used for the production of fodder for the livestock as shown in figure 5.8

When the non participant farmers limited to other mechanisms to cope up shortage of fodder for their livestock participant farmers are able to produce fodder using the harvested water as can be seen in the figure.



Figure 5.8 Fodder produced by harvested water in Angewa, Farmer feeding his calves

The mechanisms used both by the RWH technology user and non-user groups to cope up fodder shortage are sale of livestock, give some to relatives and purchasing fodder from farmers who have excess of it. But those farmers who did not face fodder shortage obtained from communal grazing land, crop bi-products, own grazing land and those who are in the RWH technology produce fodder using the harvested water.

Table 5.37 illustrates the different mechanisms used by the sample households who faced fodder shortage.

Table 5.37 Mechanisms used by farm households who faced fodder shortage

	RWH user	RWH non user
	% (N)	% (N)
Sale their livestock	60 (18)	48.4(15)
Give to relatives	10 (3)	3.1 (1)
Purchase fodder	73.3 (22)	71.9 (23)

Source: Own survey, 2009

The other interesting finding of this research is that the technology of RWH helped the farmers to get income from beehives. This is because different types of flowers can grow around the pond and the water itself and the flowers grown became foods for the bees. And with this farmers began to cultivate honey for consumption and sale both by traditional method and in a modern way as shown in figure 5.9. This further increase the income of the farmer and improve his food security status.



Figure 5.9 Farmers' traditional and modified beehives around the pond in

The total amount of income obtained by the sample households in the year 2008 mainly from agriculture excluding off-farm and remittance income is presented in table 5.38. From the table sample household farmers engaged in RWH technology received better income. And the average income of the technology user farmers ranges from 6001-9000 Eth,birr while the average income of farmers with out the technology ranges from 3001-6000 Eth,birr. From this it is possible to conclude that RWH technology increases the total income of farmers. And when farmers have high amount of income the probability for them to be food secured became high. But it does not mean that farmers with high amount of income are food secured (Ayalew, 2003).

Table 5.38 Households' agricultural income

Income category	RWH user	RWH non user
	% (N)	% (N)
1000-3000	4 (2)	44 (22)
3001-6000	14 (7)	30 (15)
6001-9000	36 (18)	14 (7)
9001-20000	24 (12)	12 (6)
>20000	22 (11)	
Total	100 (50)	100 (50)

Source: Own survey, 2009

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Promoting food production to meet the ever increasing demand of the increasing number of population in rural Ethiopia is one of the major challenges faced for the government and the farmers themselves. In rural Ethiopia, almost all the people depend on the agriculture sector to earn their livelihood. On the other hand the production of the agriculture sector depends on the amount of rainfall and the duration of it. Amount of rainfall especially in the arid and semi arid regions of the country is generally poor to meet the basic needs of crop production due to high variability and short dry spell.

In addition, most of the land in the arid and semi arid regions are degraded since it is historically cultivated, absence of vegetation cover and mismanagement.

Thus overcoming these problems in the region and promoting agricultural activities are a non-alternative solution to increase farmers' production.

Beginning from the recent past, both the federal government and regional states in collaboration with NGOs working for the well being of the rural poor in Ethiopia have begun to invest large amount of resources on rainwater harvesting technology.

In this study, the researcher investigated practices and challenges of rainwater harvesting, factors that affect farmers' decision to adopt RWHT, the perception of the local people towards the technology and lastly the role of the technology for farmers' food security were investigated.

But, the researcher believes that this is not a complete study to come up with solutions for the challenges of RWHT adoption and utilization in the study area. This is because the practice of RWHT challenges can vary from time to time and the technology is a newly introduced one in a modern way of implementation in the country. Therefore, to address all the practices and factors that affect the technology are beyond the scope of this study.

As a result, the study has knowledge gap since it did not give emphasis about the traditional RWH practices of the people, as to how the technology promote environmental sustainability, the impact of the technology on the life of women are not yet included in the study.

The study revealed that the technology has significant positive impact on agricultural production. But only few farmers are involved in the technology. And this is mainly because farmers' financial constraints, labor unavailability and lack of detail information about the rainwater harvesting technology.

The perception of farmers in the study area towards the limitation and prospects of the technology were investigated and the researcher found out that both RWHT user and non user farmers have better awareness towards the technology and non user farmers are also eager to adopt except the different constraining factors mentioned that hinder them to do so. Most of the RWHT user farmers argued that the technology improved the total income of the user farmers by helping them to produce during shortage of rainfall increase the number of harvesting period, and by avoiding crop failure. They further argued that the technology has the potential to increase yield.

On the other hand, the study revealed that due to the prevalence of high evaporation, the small amount of the collected water and the market price fluctuation for the vegetables and cash crops produced by the technology some farmers have left it as responded by few of them. And again some farmers perceived the technology as a danger for their child life, as a cause for the death for their livestock and a reason to be caught with cold. This is because of farmers' observation of death of livestock, farmer's baby and the bad odour came from the pond due to the accumulation of plant leaf and other remnants on the pond water for long period of time in some areas of the study.

The other most important finding with regard to the perception of the technology by farmers in the study area is the material, and financial support given by the government and other development agents for the adoption and utilization of the technology is found to be insignificant. So farmers underlined the need to strengthen the support given by the

different developmental institutions. And it is believed that this could enhance the proper implementation of the technology and this in turn could help the farmer to be self-reliant.

The Pearson χ^2 -test of association depicts that in the study area, adoption of RWH technology is affected by land resource and total land size of farmers', livestock availability of farmers and the number of livestock owned by the farmer, the nearest plot distance of farmers from their home. Again, the educational status as well as level of education of household heads, oxen availability, farmers' access to credit service, farmers' saving habit, farmers' use of chemical fertilizer, sources of household income.

It was found out that farmers who owned land and have relatively better land size adopt the technology. But the issue of tenure security in the study area is proved to have no significant contribution for the adoption of the technology. In addition those farmers who acquired plot relatively near to their home found out to be better adopters of the technology.

Furthermore, farmers with livestock, oxen and having relatively better number of livestock are good rainwater harvesting technology users. And also, farmers who have access and obtained credit, who developed the habit of saving, who have large family size, farmers who use chemical fertilizer, and farmers mainly whose income is totally dependent on the agriculture were better RWH technology adopters.

In general RWH technology in the study area is challenged by environment related problems, structural problems, institutional problems, and farmers' related problems for successful implementation. The soil type and the nature of the land slope are the two main challenges of the technology in the study area of Menz Mama Mider woreda. With regard to the structural problems of the technology absence of appropriate design about how to make cover, lack of de-siltation system, and cracking of concrete ponds are the major ones as revealed by this study. And, the technology can also be a cause for accidents happened on animals and human beings.

Above all, institutional problems, and problems of the farm households in the study area challenges the technology most. Problems like lack of well trained man power, inability

of the expertise to understand the technology, lack of administrative coordination among the concerned bodies, absence of farmers' capacity building and continuous follow up, shortage of provision of materials which include water lifting equipments, improved seeds with different varieties are the major institutional challenges investigated in the study. Lack of labor, financial constraints and over dependency of farmers are also major problems in the study area in the farmers side.

At the end, the final goal of RWHT implementation is to make the farmer to be food secured using environmental friendly technology. In this regard, RWHT is believed to be one of the best technologies that can increase the agricultural production of farmers since additional water source gives better chance to produce crops and cash crops during dry season. The study depicts that there is a big difference between participant and non participant farmers in terms of the amount of income earned from rain fed agriculture, from assets like livestock, and beehives. Those farmers who adopt the technology got better rain fed income by supplementing the rainfall shortage, improves the quality of their livestock by producing fodder and having better water access for their livestock drinking, and also the technology help them to produce cash crops including different types of vegetable with high market value. Further the study revealed that participant households earned 2000-3000 birr on average in yearly bases which have significant contribution for farmers' food security.

6.2 Recommendations

On the basis of the major findings of the study the following recommendations are forwarded.

The advantage of RWHT is found to be remarkable in order to improve agricultural production. While this is the fact the expansion of the technology is limited and only few farmers are privileged. This is due to financial constraints, labor unavailability and lack of detail information about the technology. Thus efforts should be made by the government and other concerned body to make the non participant farmers to adopt the technology through borrowing money that can be paid in the long term and short term with the return of the technology.

In order to prevent excessive evaporation of pond water, ponds should be designed with its cover and both material and technical support should be given for the farmer about how to cover their pond.

Market price fluctuations for the different types of cash crops produced by RWH brought dropout of farmers from the technology. Therefore, formulating intervention strategies by the government is needed in order to build a commercial institution to look for alternative market to avert the problem.

The findings of the study proved that gradually accidents on animals and human life are observed in the study area which is caused by the absence of fence for the pond. In order to avoid such situations and to enhance the acceptance of the technology advice should be given to farmers and continuous follow up is needed.

The availability of physical and financial capital in addition to the educational level of farm household heads, plot distance from the home of farmers, labor availability and utilization of fertilizer affect the decision of farmers to adopt RWHT. As a result, the effort of the government is needed to provide education for all citizens in order to have educated farmers, to provide credit and educate the farmer about saving and establish micro finance institutions at kebele level.

The study discloses that absence of coordination among stakeholders (which include farmers, government institutions, and NGOs) became major challenge for the failure of the technology since this in turn could be a cause for an act of corruption, and wastage of resources which further hinder the quality of the pond. Therefore, there should be a need to coordinate the different stakeholders and to develop a follow up system.

Further the study portrays that inappropriate pond site selection, poor pond quality construction, absence of appropriate water lifting materials, failure of the woreda agriculture bureau to provide agricultural input are the major challenges of RWHT in the study area. Thus government support will be needed to hire skilled labor having good knowledge of pond construction, to provide pedal pump and cannel made of plastic to lift

and take the water from the pond, to provide agricultural inputs which include improved seeds, and fertilizers.

And the need to build households capacity through training has paramount importance about the adoption and utilization of the technology. The study came up with the result that farmers got training about how to dig pond, how to select pond location, and about the purposes of the stored water. But, some farmers faced problem when they tried to implement the training. For this, one reason could be the lack of continuity of the training. Therefore, intensive training is needed and should be arranged for farmers and the training should be updated time to time to build farmers knowledge about RWHT implementation.

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Annex-1

Questionnaire

Dear respondents, this study aims at assessing the agricultural use of rainwater harvesting in Menz Mama Mider woreda. Consequently, it is quite free from politics or what so ever, Hence you are kindly requested to give your genuine responses.

Thank you very much in advance

I) Household information

1.1 Information on HH head

1 Age of the HHH _____ (yrs)

2 Sex 1. Male 2. Female

3 What is the level of education of the HH head?

1. Read and write 2.primary 3. Secondary 4.Tertiary

4 Family size _____

1.2 Information on HH members

5 Is your wife/husband educated? 1. Yes 2. No

6 If yes, what is the level of education?

1. Read and write 2.Primary 3. Secondary 4.Tertiary

7. Do you have educated sons/ daughter? 1. Yes 2. No

II) Practices and challenges of rainwater harvesting

8 Do you have information about rainwater harvesting before you engaged in?

1. Yes 2. No

9 If yes have you started rainwater harvesting? 1. Yes 2. No

10 When you have started? _____ Year

11 For what purpose you use the stored water? (You can tick more than one)

1. For crop production 2. For domestic purpose 3. For livestock 4. Other (specify) _____

12 Who is responsible to manage the harvested rainwater in your area? (You can tick more than one) 1. Community leaders 2. Individual household's 3.No responsible body

4. Other (specify) _____

13 Is there selection of households to adopt RWH technology? 1. Yes 2. No

14 If yes, who is directly involved in the selection of households for RWH Technology?

1. The woreda bureau of agriculture 2.Extension workers 3.The kebele officials.

4. Other (specify) _____

15.If no, how you get involved in the technology? 1. Personal initiative 2.Learn from neighbors 3.Other (specify) _____

16. Do you think that the selection process is criteria based? 1. Yes 2.No

17 If yes, what are the possible criteria used? 1. Land suitability to the structure 2.Willingness of farmers 3.Rainfall pattern 4.Other (specify) _____

18 Have you got any training on RWH? 1. Yes 2. No

19 If yes, what kind of training you have got? 1. How to select pond location 2.How to dig pond 3.Purpose of pond 4.Other (specify) _____

20 Was the training about how to use the water obtained from the pond effectively?

1 Yes

2.No

21 Would you tell me the way you use the water for the purpose you need?

22 How do you see the number of RWH storage? 1. Increasing 2.Decreasing 3. No change

23 How about the quality? 1. Poor 2. Good

24 If you say that the quality is poor, what are the reasons? (You can tick more than one)

1. Quota system expansion 2.Lack of skilled labor 3.Financial problem 4.Other (specify) _____

25 Do you have local planners to plan and implement the expansion process? 1. Yes 2.No

26 Which kind of pond you have? 1. Plastic lined pond 2.Clay lined pond 3.Cement lined pond 4.Other (specify) _____

27 Which pond type is your preference? 1. Communal ponds 2.Individual ponds

28 What are your reasons? _____

29 How do you dig your pond? 1. In cooperation with others 2.Personally 3. Using family labor 4.Other (specify) _____

30 Does your pond have cover? 1. Yes 2.No

31 If yes, what are the materials used? (Specify)_____

32 If no, why not? (Specify) _____

33 What kind of challenges you have faced due to absence of cover? (Specify)

34 Does your pond have fence? 1. Yes 2.No

35 If yes, what are the materials used? Specify _____

36 If no, why not? Specify _____

37 What are the sources of runoff to your pond? 1. Small external catchments
2.With in the farm 3.From upstream catchments 4.From direct rainfall

38 Which of the following reasons necessitate you to adopt RWH technology?
(You can tick more than one) 1. Shortage of water 2.Soil degradation 3.The need
to produce more 4.Pressure from development agents

39. Indicate which of the following challenges you have faced when you use
RWH technology?

Land shortage	Financial capital	Knowledge constrains	Absence of follow up	Material shortage	Other (specify)

40 What possible solutions would you suggest for the problems you mentioned?
Specify

III Perception of the local community towards rainwater harvesting

41 Do you think that complications due to the amount and distribution of rainfall
could be averted through expansion of RWH technology? 1. Yes 2.No

42 If yes, how? _____

43 If no, why not? _____

44 Have you observed any disadvantage of RWH? 1. Yes 2.No

45 If yes, what are these disadvantages? 1. Health impact 2. Sudden human life loss

3. Sudden livestock life loss 4.Other (Specify)

46 Can you say that RWH is a solution to food security? 1. Yes 2.No

47 If no, what do you suggest as the best means of food security? Specify _____

48 If yes, what change do you observe in the food security condition of the participant?

Specify _____

49 Is the assistance given by the government and other non governmental organization for RWH technology adequate? 1. Yes 2.No

50 Does the assistance create self-reliance or dependency?

1. Self-reliance 2.Dependency

51 Do you think that sharing the construction cost of RWH increases the efficiency of the technology? 1. Yes 2.No

52 If yes, why? Specify _____

53 Who is more effective in the utilization of RWH technology?

1. Men 2.Women 3.Both

54 Do you think that expansion of RAH technology will narrow down your cultivated land? 1. Yes 2.No

55 If yes, why? Specify _____

56 If no, why not? Specify _____

IV Factors that affect household decision to adopt rainwater harvesting ponds.

Section-1 Land resource

57 Do you have your own land? 1. Yes 2. No

58 If no, how you cultivate crops? 1. By renting 2.By share cropping 3.Other
(Specify) _____

59 If yes, what is the total size of land you have? _____ in ha/Timad

60 Do you feel tenure security? 1. Yes 2. No

61 How long you travel from your home to the nearest plot in hours?

1. Less than an hour 2.An hour 3.Two hours 4.Other (Specify) _____

Section-2 Livestock

62 Do you have livestock excluding oxen? 1. Yes 2.No

63 Do you have oxen? 1. Yes 2.No

64 If you do not have, how do you get oxen when you need?

1. Borrow from friends 2.Coupling with other farmer 3.Hire from some one

4. Other (specify) _____

65 Have you faced fodder shortage for your livestock? 1. Yes 2.No

66 If yes, what you did? 1. Sale of livestock 2.Give some to relative 3.Purchase
fodder

4. Other (specify) _____

67 If no, what are the sources? 1. Communal grazing land 2.Crop by products
3.Own grazing land 4.Other (Specify)

Section -3 Other agricultural inputs

68 Do you have access to credit service? 1. Yes 2.No

69 If no, do you need to have access to credit service? 1. Yes 2.No

70 If yes, have you obtained credit? 1. Yes 2.No

71 Who provide the credit for you? 1. Government 2. Private credit association
3.NGOs

4. Other (Specify) _____

72 What are your reasons not to take credit (You can tick more than one) 1.Being
afraid of credit

2. Insufficient supply 3.Inability to repay back previous credit 4.Other
(specify)_____

73 Have you obtained the amount you need? 1. Yes 2.No

74 For what purpose you obtained credit? 1. To construct RWH ponds 2.To buy
food 3.to purchase agricultural inputs 4.Other (specify) _____

75 Are you engaged in saving? 1. Yes 2.No

76 If no, what is your reason? 1. Do not know its advantage 2.Shortage of money
to save 3.Other (specify) _____

77 If yes, in what way do you save? 1. In the bank 2.Buying livestock 3.Ikub
4.Other (specify) _____

78 Do you use chemical fertilizer? 1. Yes 2.No

79 If no, why not? 1. Difficult to afford the price 2.No soil fertility problem
3.Shortage of supply in the market 4.Other (specify) _____

80 Do you use manure/compost? 1. Yes 2.No

81 If no, why not? Specify _____

Section-4 Household income and expenditure

82 Identify your income source, expenditure and the amount of income earned in the table below for the year 2008.

Sources of income (code:1=on- farm,2= off-farm, 3=remittance)		Amount earned	Expenditure	Sub- total
On-farm income such as from sale of livestock, crop, beehives, and poultry				
Off-farm income such as pity trade engaging in sales of: local drink, fire wood, daily laborer				
Remittance and other				
Year total				

Section -5 Labor

83 Is your family enough for RWH operation? 1. Yes 2.No

84 If no, how do you get additional labor?

1. Relatives 2.Hired labor 3.Exchange (wonfel) 4.Other (specify) _____

85 How do you see the trend of your labor consumption?

1. Increasing 2.Decreasing 3.No change 4.Other (specify) _____

86 If it is increasing, why? Specify _____

V Role of RWH for food security in the study area

87 Are you food secured? 1. Yes 2.No

88 In what way rainwater harvesting help you to be food secured? 1.It avoids crop failure during dry season 2.Helps us to produce during dry spell period 3.Increases the number of harvesting time per year 4.It increases the amount of yield harvested 5.Other (specify) _____

89 If RWH do not contribute for food security, why? 1. High evaporation 2. Less amount of the water 3.Lack of market for the product 4.Other (specify) _____

90 Which of the following season in your local area the most crops harvesting season?

1. Belg 2.Meher 3.Belg and Maher

91 What was your yield in 2008 per hectare? 1. Increasing 2.Decreasing 3. No change

92 How much total income you earned from agriculture in the year 2008 in birr_____

93 Do you think that you have gained additional income because of your involvement in rainwater harvesting? 1. Yes 2.No

94 If yes, how much? in birr _____

95 If no, what are the reasons? 1. Ineffectiveness of the technology 2.Shortage of land 3.Lack of experience 4.Other (specify) _____

96 Did you produce new crops because of your engagement in RAH technology? 1. Yes 2.No

97 If yes, mention three types of crops? _____

Checklist for Focus group Discussion and Key informant interview

Annex-2

I Focus group discussion for participant households in rainwater harvesting

- 1 What is your opinion towards rain water harvesting?
- 2 How do you become get involved in rainwater harvesting practice?
- 3 Do you think that your engagement in rainwater harvesting improves your food security status? , how?
- 4 For what purpose you use the harvested water?
- 5 What were the measures taken at the time of water shortage before you engage in RWH?
- 6 What kind of pond you have and why do you prefer it?
- 7 Are you still ready to excavate additional ponds?
- 8 How much does it costs to construct one rainwater harvesting pond?
- 9 What are the challenges you have faced when you engaged in rainwater harvesting? Which challenges are still persistent?
- 10 What are the most important factors that you have considered when you engaged in rainwater harvesting?
- 11 Do you agree that rain water harvesting can help you to produce more crop production?
- 12 Have you grown new crops after engaging in rain water harvesting? , what are the new crops grown?
- 13 Do you think that the presence of water shortage can be solved by rainwater harvesting?
- 14 When you use the collected water? , how many times you produce crops before and after engaging in rain water harvesting?
- 15 What are the major benefits that you get because of your involvement in rain water harvesting? What about the losses
- 16 Do you think that you have better food security status than the non-participant?

Annex-3

II Focus group discussion for non-participant households of rainwater harvesting

- 1 What is your opinion towards rainwater harvesting?
- 2 What are your reasons not to involve in rain water harvesting technology?
- 3 Have you obtained credit? Why?
4. Do you use chemical fertilizer? If not, why?
- 3 Do you think that rain water harvesting can improve food security? How?
- 4 What measures you take when you face water shortage for agricultural use?
- 5 Have you planned to harvest rainwater in the future?
6. What kind of pond you have and why do you prefer it?
- 6 Have you observed better food security condition of households who engaged in the technology than people like you?

Annex-4

III Discussion guide for key informant interview with rainwater harvesting participant households?

- 1 What are the major reasons for your engagement in rain water harvesting?
- 2 How many ponds you have?
- 3 have you obtained credit? Why?
- 3 Are all your ponds full through out the year?
- 4What are the major challenges you have faced?
- 4 Do you have ponds which are non-functional? Why?
- 4 What are the major challenges you faced when you dig your pond, and use the harvested water?
- 5 Do you use chemical fertilizer? If not, why?
- 5 What relationship you have with other participant households and with the non-participants?

6 What relationship you have with the kebele administrative officers, woreda Agriculture and rural development water department bureau, with the development agents (DAs), and with NGOs concerning rainwater harvesting technology?

7 Are you a member of small micro-finance association in your local area?

8 Is there any change in your feeding before and after engaging in rain water harvesting? What are the changes?

Annex-5

IV Discussion guide for key informant interview with the kebele administrative officers

9 Are you rain water harvesting technology participant?

10 How do you see rain water harvesting technology?

11 How about the acceptance of the technology by the people in your kebele?

12 Have you established RWH association? When?

13 Who is responsible in the selection of rain water harvesting participant house

Holds and in what base the selection is?

14 What are the major problems you have faced for the implementation of the technology?

15 What are the factors that affect households to adopt rainwater harvesting?

14 In what way you gave support to the households?

15 Can you say that rain water harvesting technology is expanding in your kebele? What are the possible reasons?

Quota system

Effectiveness of the technology

Farmers' motivation

Others (if any) _____

16 Who is responsible to give support for the implementation of the technology? And what kind of support they provide?

17 How do you see the food security status of the RWH participants and non-participant households?

Annex-6

V Discussion guide for key informant interview with the kebele extension workers

- 1 How do you see the participation of the household in rain water harvesting?
- 2 How do you consult the households and what are the major feedback areas that you gave?
- 3 What are the major problems that faced the households to adopt rainwater harvesting technology?
- 4 Can you say that the income of households who participate in rainwater harvesting is better than the non participant?
- 5 How do you see the rainfall variability in your surrounding?
- 6 Which of the following natural parameter affect households to adopt and utilize RWHT?

Topography

Run off surface

Infiltration rate

Soil type

- 7 How often do you visit the households who are participating in RWH?
- 8 Are you living very close to the households' resident?
- 9 Are you recommending better and new seeds to the households to make them more productive?
- 10 Can you say that the number of RAH user households increasing? What are the possible reasons?
- 11 What kind of relation you have with the house holds, with the kebele administrators and the woreda agriculture water department bureau?
- 12 what is your profession and level of education? How often you have got training and what were the issues?

Annex-7

VI Discussion guide for key informant interview with the woreda Agriculture and natural resource department bureau

- 1 When you have started the dissemination of RWH technology to each woreda kebeles?
- 2 What are the major reasons for the spreading of the technology?
- 3 Can you say that the awareness of the community towards the RWH technology is good?
- 4 How do you see the participation of the household in rainwater harvesting?
- 5 What are the major challenges that faced you from the start up to the effectiveness of the RWH technology?
- 6 What are the factors that are taken in to consideration for the adoption of the technology?
- 7 What are the materials and machines that you supply to the households for the purpose of RWH technology?
- 8 Who provide the RWH materials and machines for the implementation of the technology?
- 9 Do you have enough experts in RWH who are responsible to give different training for the households?
- 10 Can you say that RWH is a non alternative technology in the woreda?
- 11 How do you see the food security status of the households who adopt RWH technology as compared to the non participant households?

Annex-8

VII Discussion guide for key informant interview with non governmental organizations who are working to enhance RWH technology

- 1 When you have started in giving support for the implementation of RWH technology in the woreda?
- 2 In what aspect you are helping the woreda about RWH?
- 3 Are there challenges that you faced when you perform your mission?
- 4 How do you see the performance of the woreda towards the implementation of RWH technology as compared to other woredas that you engaged in?
- 5 Does your contact directly with the woreda officials or with the end users?
- 6 What are the problems that are new in the woreda?
- 7 How do you see the perception of the people towards RWH technology?
- 8 Have you observed any improvement in the food security condition of RWH participant households?

DECLARATION

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

Declared by:

Emishaw Girma

9/1/2020

Candidate

Confirmed by:

Advisor