UNIVERSITY OF NAIROBI
DEPARTMENT OF SOCIOLOGY AND SOCIAL WORK

FACTORS INFLUENCING ADOPTION AND UTILIZATION OF RAINWATER HARVESTING TECHNOLOGIES AT HOUSEHOLD LEVEL IN EVURORE WARD, MBEERE NORTH SUB-COUNTY, KENYA

BY
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DECLARATION

This research project is my original work and has not been submitted for a degree or any award in any other university.

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SIGNATURE……………………….   DATE…………………………….

Declaration by the Supervisor

This research project has been submitted for examination with my approval as the university supervisor.

DR BENEAH MUTSOSTSO
SENIOR LECTURER

SIGNATURE………………………   DATE…………………….

DEDICATION

I wish to dedicate this project to my adorable parents Mr. Faustin Nthiga and Mrs. Jemimah, my dear siblings Wilson, Dicksent, Phenehas, Arthur, Julie, Shallom and Jane. To my lovely niece Joy and my son baby Jerry for being there for me whenever I required their help. You are family to cherish!

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Sincere thanks to my research participants; the household heads, the key informant from the Agricultural office and water offices without whose input, the study would not have been a success. Finally, I am much grateful to the Almighty God for seeing me through the period of study.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	-	African Development Bank
ASALS	-	Arid and Semi-Arid Lands
ATPS	-	Indigenous Rain Water Harvesting Practices
FAO	-	Food Agricultural Organization
FGD	-	Focused Group Discussion
FREGs	-	Farmers Research External Groups
FTCs	-	Farmers Training Centres
GOK	-	Government of Kenya
IFAD	-	International Fund for Agricultural Development
IMF	-	International Monetary Fund
KARI	-	Kenya Agricultural Research Institute
KIG	-	Key Informant Guide
KNBS	-	Kenya National Bureau of Statistics
MDG	-	Millennium Development Goals
RELMA	-	Regional Land Management Unit
RWHT	-	Rainwater Harvesting Technology
UN	-	United Nations
UNEP	-	United Nations Environmental Programme
UNFCC	-	United Nations Framework Convention on Climate

ABSTRACT

Technology refers to the application of scientific knowledge for practical purposes and it is closely related to development throughout the world, in informal organisations, factories, and farming system. Adoption of technological production can assist a resource-poor country to overcome its natural handicaps and conversely a county which relies on its rich diversity of natural resources may stagnate and fall victim to the perils of underdevelopment. In Kenya, there is poor accessibility of viable safe drinking and nearly 70% of the people reside in rural areas whereby the main sources of livelihood are dependent on rainwater.

This study examined factors adoption and utilization of rainwater harvesting technologies in Evurore ward, Mbeere North sub-county. More specifically the study examined sources of knowledge for rainwater harvesting technologies, factors that enable households adopt rainwater harvesting technologies, benefits of utilisation of rainwater harvesting technologies among households and the challenges faced by households in adopting rainwater harvesting technologies.

A mixed method approach was applied to generate quantitative and qualitative data using the questionnaires, FGDs and observation methods. The study drew a sample of 114 respondents from a possible universe of 760 farmers. The quantitative data were analysed using Statistical Package for Social Sciences (SPSS), the descriptive statistics was computed and data presented using tables. Qualitative data was analysed using the ATLAS and presented through quotations.

The study found out that rainwater harvesting is essential for households both in rural and urban areas of Kenya and its largely practiced. The key factors influencing adoption and utilisation of rainwater harvesting technologies include, the available knowledge about RWH and some of the benefits that are as the result of adoption; water harvested is used for irrigation, for livestock, cooking, drinking, washing and too sold to non-harvesters or those that harvest less. Availability of capital and labor too contribute to the adoption of water harvesting technologies for farm and for domestic use.

The study recommends the following; education and training of farmers on modern technologies of rainwater harvesting, emphasizes on community mobilisation and sensitization about rainwater harvesting technologies, stresses on the need for more contact with agricultural extensions at the village level and too recommend that value chain analysis of crop production be undertaken.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Technology refers to the application of scientific knowledge for practical purposes. It makes it possible to have possibilities and options (Kelly, 2012). It is synonymous with saving time and costs for society. It makes what initially looked impossible to be possible and what appeared unmanageable to be manageable. It is associated with or about techniques used to manage knowledge and applied to practical situations for the good of man.

Technology is closely related to development throughout the world and informal organizations, factories and farming system. Adoption of technological production can assist a resource-poor country to overcome its natural handicaps. Conversely that County which relies on its rich diversity of natural resources may stagnate and fall victim to the perils of underdevelopment. Therefore technology adoption remains the prime mover of economic development and quality of in all social systems.

According to OECD, (2010), Innovation is about changing concepts into values. It leads to improved goods, services and processes. Further, an innovation may be a new idea to the people. As defined by Rogers (1995), innovation is a thing or an idea that is thought of to be new by an individual or by other units of adoption. What matters most is the uniqueness of an idea but not its novelty. Hence to the adopters the modernisation does not mean much benefits to them. Innovation can be something tangible like a machine and too can be something non-concrete like an idea. Studies on innovation have always been interested in the spread of the idea. Rogers (1983) states that in studies on adoption, is a process or set of stages that establish different systems relating to decisions that can make the technology adopted achieve confirmation.

In his report, Arthur, (2011) noted that high-tech innovation is the cornerstone for economic development. Then Goh, (2002) defines technological innovation as the process through which technological advances are produced. On the other hand, diffusion is the process by which an innovation is communicated among the community members overtime through certain systems. It is the way in which the information concerning the new idea or object is spread. The adoption of technology by individuals, industry and agricultural system is of focus to many researchers Sherit and Browne, (2006).The benefits of technological innovation, especially to individual, need to be communicated to everyone to increase chances in the acceptance and transmission of the said technological innovation.

In South Asia rainwater harvesting has been practised for last 8000 years. South Asia has got the longest history of Rainwater harvesting in the world. In India, rainwater harvesting began in the ancient days as a way to adjust to the changes of climate. In a changing climate, early farmers applied rainwater harvesting which has been crucial for establishment and diversification of food production. In response to climate extremes rainwater harvesting boosts the resilience of human society (Pandey, Gupta, & Anderson, 2003).

In 1994, there was an unusual drought in Japan. The following year after the Great Hanshin-Awaji Earthquake Japan experienced water supply problems and this brought about the need for obtaining water sources in the perspective of disaster preparedness. With these experiences, a great number of cities felt the need to reconsider the significance of rainwater harvesting in the last decade. They focused on getting alternative water sources, ways to avert urban flooding, and obtaining extra water for disaster –responses. Therefore, as per the recommendations and considering the local conditions, they are trying to endorse rainwater harvesting and storage positively (Furumai, Kim, Imbe, & okui, 2008). In their study on factors affecting farmers adoption of technologies in farming systems in Japan, (Chi and Yamada, 2002) found that access to the technical training, gathering, verbal transmission, believe on the technician and believe in the technology introduced by scientist as some of the factors contributing to the adoption of the technology. They further reported that young and educated farmers are known to adopt the technology. Nevertheless, not all farmers who adopt the technologies because they are new to them but some are doubtful of the new idea because they are not certain of good produce. Generally these are farmers of old age who work based on their own experiences.

Andoh, Gupta, & Khare, (2018) writes that in the semi-arid parts of East Africa (e.g. Tanzania and Kenya), and Burkina Faso of West Africa RHW systems are widely practised, though in Ghana the practice is different. It is hardly practised in the organisations despite being integrated into many missionaries and government residences in the colonial period. Among the households in Ghana, RWH entails the use of small water storage containers of an average volume of 16 litres which are placed below the tips of the roof to collect water when it rains and later these containers are transferred to the main storage containers in the houses by women and children. Other communities depend on boreholes, unprotected streams, dams, rivers, dug-outs and impound reservoirs for domestic use of which some were drinking places for animals and hence posing endless health risks. Water from roof catchment is confirmed as among the most growing domestic water resource. In the year 2012, USAID introduced Ghana WASH project which provided some services comprising RWH systems to numerous communities in Central, Western and the Greater Accra.

Opare (2012) in his study on Rainwater harvesting in Ghana found that: all households practised water harvesting and though its extensive use, it was the main source of water for merely 5.7% of the homes as all harvested water was utilised during the rainy season. Consequently, this suggested that a bigger number of households used the unsafe river and lake sources even with the knowledge of the extensive pollution levels. Despite the much rains received in the seasons per year, the households were not still able to stock water for use in the dry season. The use of permeable roofing materials and insufficient containers for water storage in the households was a limitation to the low utilization of harvested water.

More than 80% of Kenya is arid and semi-arid characterised by irregular rainfall, high evapotranspiration rates, and brittle soils unsuitable for sustainable rain-fed agriculture (Miriti et.al. 2012; McCown and Joness (1992). Jury (2002) agrees with this by saying that the quantity of water in the soil accessible to crops depends on when the rainfall starts, its span, and culmination which affect the success or failure of a growing season. Particularly, this represents Sub-Saharan Africa (SSA) where farming practices mainly depend on rainfall yet crop production cannot be projected in our near future. In a study of Thika East Sub-county on adoption of modern agricultural technologies by small scale farmers, (Nyandika 2016) found out that, inadequate extension services, low access to resources and agricultural research centres and their research products negatively influenced the adoption of modern agricultural technologies.

Mbeere sub-county is the driest part of Embu County in Kenya. The semi-arid area continues to experience much rainfall differences, obstinate dry spells, long periods of droughts and high evapotranspiration (Micheni et al 2004). Kimani et al. (2003) noted that the area has always had plenty of water for agricultural practices though it is poorly distributed over time. As a result, the water stress leads to complete failure of crops (Meehl et al. 2007). The main challenge in the drier parts of Embu County is on how to make good use of every drop of rainwater that falls to raise agricultural production. Otherwise food security situation is expected to continue getting worse and may possibly deteriorate in the days to come if on-farm rainwater harvesting and integrated soil fertility technologies are not taken up quickly in the semi-arid areas of Embu County.

1.2 Problem Statement

Kenya is deprived of access to viable safe drinking and water for sanitation. Target 10 of the MDGs intended to lessen by half the fraction of the people globally by 2015 that did not have access to safe water and would also focus on Kenya where almost 70% of its people reside in rural areas whereby farmers depend on rain for plants growth and keeping of livestock as the main sources of livelihood. Additionally, the World Bank (2010) reported that the population was increasing at a rate of 2.6 %/year. Kenyans highly depend on seasonal rainfall. In his report, Malesu et al. (2007) anticipates temperature increase and rainfall decline in semi-arid areas by 2030 due to climate change. Water scarcity in Kenya is perilous to its social-economic development hence makes the realisation of Vision 2030 and the international development agenda in the SDGs is doubtful. The water problem is strengthened by the change of climate and rising water demand because of the growth of the population and urbanisation.

Kenya chapter of the Billion Dollar Alliance for Rainwater Harvesting initiative was launched in 2017 by the Kenyan government and its partners from the development and business community. It was continent-wide and was designed to scale up farm pond technology for agribusiness and livelihood resilience for dryland farming systems. The aim of the alliance was to build one million farm ponds in Kenya to intensify water storage in the farms. The ponds are to be constructed at the rate of 100,000 ponds every year for ten years.

Medina (2016) describes water harvesting as the process in which the rain that falls on a site is diverted, captured and stored for use either on the same location or on a different one for use. Rainwater is collected and stored for use at home, use for small scale productive activities and watering of the garden (Mwenga-Kahinda, et al., 2007). Rainwater harvesting for farm use can highly increase its productivity, boost food security and reduce poverty. Therefore it can be applied to lessen time-based water supply problems and add-on conventional water supply systems (Mwenga-Kahinda, et al., 2007). In Eastern Kenya and particularly in the semi-arid rural areas the practice of water harvesting has not been exploited in totality. Therefore, water harvesting techniques can be useful devices for enhancing the ability or resilience of household's to mitigate the problems faced by rural farmers.

In Embu County, water is a constraining factor that limits productivity for both crop production and livestock productivity. Embu county has only 5% area under irrigation and there is much potential to increased irrigation through water harvesting and storage in ponds and pans. (GOK, 2013) up to 80% of the population is food secure and 20% of the population face perennial food shortages and insecurity due to low productivity. The hot and dry semi-arid regions of Mbeere North and South mainly experience acute food insecurity. The areas receive low and unreliable rainfall (GOK, 2013).

There is substantial knowledge of rainwater harvesting in Kenya. Mbogo (2014) analysed the types of technologies for rainwater harvesting practiced in Mbeere Sub-county of Embu County. Among the key findings were that the type of household dwelling influenced the respondents to embrace rainwater harvesting technology. The study did not delve into how the harvested water is utilised. Given the issue of climate change and insufficient rainfall, water scarcity has become endemic thereby undermining farm productivity. In a water-deficit region of Mbeere it was found prudent to probe how the rainwater harvested is utilized and the effect it has on household resilience and quality of life. Therefore this study explored key factors influencing the adoption and utilisation of rainwater harvesting technologies for domestic and agricultural production among households in Evurore ward, Mbeere North Sub-county.

1.3 Research Questions

i. What are the sources of knowledge for rainwater harvesting technologies?
ii. What are the enabling factors on adoption of rainwater harvesting technologies?
iii. What benefits has utilisation of rainwater harvesting brought to households?
iv. What challenges are faced by households in adopting rainwater harvesting technologies for agriculture and domestic consumption?

1.4 Objectives of the Study

1.4.1 Main Objective of the Study

The main objective of the study was to find out the causal factors for household adoption and utilisation of rainwater harvesting technologies for domestic and agricultural production in Evurore ward, Mbeere North Sub-county.

1.4.2 Specific Objectives

i. To understand the sources of knowledge for rainwater harvesting technologies.
ii. To establish enabling factors for households adoption of water harvesting technologies.
iii. To explore the benefits of utilising rainwater harvesting technologies among households.
iv. To investigate the challenges faced by households in adopting rainwater harvesting technologies.

1.5 Justification of the Study

The study was to determine the problems associated with the adoption of water harvesting technologies among households in Mbeere North Sub-county. Academically, the study may generate knowledge for further study. The results of the study could also establish the challenges that households face which can be adopted by the county, National government, and other development agencies to improve access to water and water conservation. The findings could possibly help improve food security for the area residents.

1.6 The Scope of the Study

The scope of the study concentrated on the; the sources of knowledge for rainwater harvesting technologies; factors that enable households to adopt rainwater harvesting technologies, benefits of utilising rainwater harvesting technologies and challenges faced by households in adopting rainwater harvesting technologies. The study was limited to Mbeere North Sub-county of Embu County. It concentrated on households that are already harvesting water and utilising it for domestic consumption and agricultural production.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter outlines an empirical literature review on causal factors for household adoption and utilisation of rainwater harvesting technologies. These will include sources of knowledge, enabling factors, benefits of utilisation and challenges of adoption. The chapter too, summarises the theoretical framework and conceptual framework of the study.

2.2 Rainwater Harvesting

The unpredictability of rainfall has led to the sprouting of numerous water harvesting schemes in Kenya and other water-stressed countries so as to decrease drought and water shortages. Water harvesting involves the following practices; diverting water from the source, collecting, storing, using, and managing of runoff through various schemes. This water is used for domestic purposes, cattle, irrigation and/or commercial purposes. This entails efficient management of water in dams, protecting soils to avoid excessive evaporation, storing rainwater in tanks, or collecting rainwater from roof-tops.

Over the last thirty years, the need for water harvesting has rapidly increased in various parts of Kenya. Rainwater harvesting projects have been carried out throughout the country so as to provide solutions to water problems. RWH tanks provide quality water for domestic use during dry seasons when water sources are limited. For farming, the water harvested is used by the growing crops and hence increasing the harvest when there is inadequate water. RWH plays a key role in rehabilitating of overgrazed lands, providing water for livestock, for commercial purposes, and for irrigation during dry seasons. Further, RWH brings about improvements in people's livelihood hence reducing the poverty levels since this enhances good health, improved sanitation, increased food security, and economic growth (Black *et al.*, 2012).

2.3 Rainwater Harvesting Technologies

Water harvesting for domestic, agricultural, pastoral, and commercial needs have been practised for ages. Development projects in Kenya by the government, non-governmental organisations, global organisations, and other agencies have focused on sensitisation and implementation of rainwater harvesting technologies in different regions of Kenya as one of the major solutions. Regardless of these increasing interventions, Rainwater harvesting schemes executed by third party actors face a lot of problems. Black *et al.*, (2012) notes that rainwater harvesting projects executed by outsiders faced problems in the field and a number of them end up collapsing soon after completion.

There are several rainwater harvesting techniques practised and a few of them are discussed below;

2.3.1 Roof Water Harvesting

Falling rainwater is collected from rooftops of houses and other structures which is then diverted into storage structures through a system of gutters. The water stored usually in tanks is used for cooking and basic sanitation. The tanks can either be plastic or concrete made. Rainwater harvesting tanks just gained extensive popularity in the last few decades despite being introduced in the early 1900s.

2.3.2 Ponds, Pans, and Dams

These are natural or constructed basin structures where water is collected and stored from some external catchment area. They vary in size, starting with small farm ponds to large community earth dams. Depending on their storage capacity water harvested is used for home purposes, small-scale irrigation and for livestock purposes. These structures are all over in Kenya and are of great importance for the survival of livestock in arid and semi-arid zones (Malesu *et al.*, 2007).

2.3.3 Fanya Juu

It is a hill-slope terracing technique that has attracted many people in several areas of Kenya. In the making of the terrace, the soil is dug and thrown upslope to form an embankment. The furrow dug along the contour retains water while the bank obstructs runoff. Over time flats terraces develop naturally. The levelled terraced land retains water in the soil preventing runoff. On the levelled ground, crops with high water retention like bananas are grown. At first this technique was encouraged only as way of soil conservation and later got recognised as a technique for water harvesting and conservation. This technique has successfully been practiced at the grassroots level, especially in the Kitui and Machakos districts of Kenya where it has gained much attention.

2.3.4 Road or Path Runoff

This is where runoff from the roads and paths is captured and diverted to a farm, pond or pastureland through a system of canals. The practice is commonly practised in Mwingi, Laikipia, Nakuru, Machokos and Kitui Districts (Black *et al.*, 2012).

Catchment-based system

Rainwater harvesting may be categorised according to the type of catchment surface and how that water it is used.

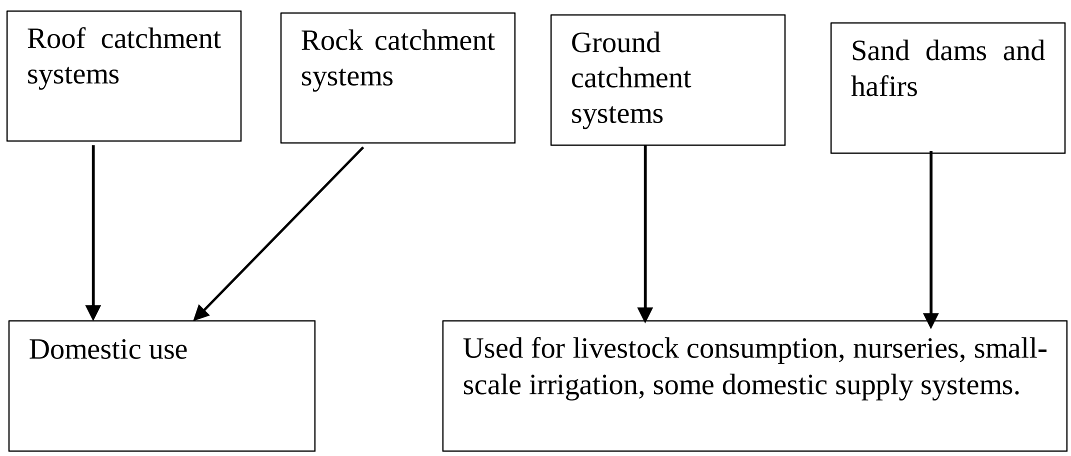


Figure 2.1: Small scale rainwater harvesting systems and uses

2.4 Sources of Knowledge for Rainwater Harvesting Technologies

Information is found in the information sources. Sources of information are different and particular users get the information that is related to them. Knowledge about rainwater harvesting can be acquired through Colleagues, friends, extension workers, radio, book/leaflets, phones, magazines and newspapers, libraries and institutes. Moreover, observation of people organisations, speeches, documents, picture, and artwork can also be described as information sources (Davis Just and David Zilberman *et al.*, 2016). The information available about a certain technology affects greatly its adoption. This helps to create general awareness of that particular technology. There are many possible sources of knowledge in RWH (Senkondo,E.M.M *et al.,* 1999).

Discussed below are some sources of knowledge for rainwater harvesting technologies.
Firstly, we have native or indigenous knowledge. These are the abilities and values that societies develop with their long interactions with their normal settings. In making their day to day life decision, the rural communities are informed by the local knowledge. A study on rainwater harvesting in Tanzania discovered that most farmers practiced RWH out their own initiatives or by use of indigenous knowledge (Senkondo,E.M.M *et al.*, 1999). Over centuries, individual societies in Tanzania have developed traditional water harvesting techniques including the excavated bunded basins. The old techniques have been viable for several years because they agree with the local lifestyle, local institutional patters and local systems (ATPS, 2013).

Secondly, we have non-governmental organisation. It's a no-profit organisation, not a direct part of the government either at local, state or at global level. In the driest parts of Kenya, several water harvesting practises have been supported by some global organisations and institutions (FAO, IFAD, and RELMA) to boost water accessibility for many purposes like production of food (ABD, 2009). Capacity building to the target populations is done through attending workshops, seminars, conferences, training, field trips, and exposure visits. They are educated on how to make use of the water bodies without contaminating them. On the other hand, groups are formed in the village, rallies, sanitation and health committees to enhance social mobilization hence sensitization of the communities to keep this issue on agenda.

The government of Kenya has also started to show a sincere concern in rainwater harvesting since 1999 to improve the dreadful state of water and water sources. This got to climax in the year 2002 in the Water Act when the plan for action was laid out. The policy on National Water Harvesting and Storage Management was released in the year 2010 and the first document of that nature by the government outlines what is required in storing of water, managing and what the way forward should be. Black, Oduor, Cheregony, & Nyabenge, (2012) notes that the script represented a good first step towards integrating rainwater harvesting to help curb Kenya's water needs at the national level and this had to be followed up with further action.

Shared experiences from regional initiatives also aim at promoting technology adoption. For instance in Southern Africa, (Gould, 2000) reports that the Mvula Trust was coordinating a three-year programme to promote Water harvesting both for domestic and farm use across six nations in the region.

Farmers also go for study tours to other places to learn more about new ideas. Star (2018) reports that six members of parliament from Murang'a visited Kenyatta village in Yatta constituency to learn about water pans. They were trained on water harvesting and commercial farming to enhance the initiative by the national government to construct hundreds of water pans in Murang'a to help locals harvest rainwater for irrigation and turn the county into a food basket. Mwariri (2003) in his study on the diffusion of small-scale rainwater harvesting technologies in the arid and semi-arid regions in Nakuru Kenya, reports that though some respondents never went to Famers Training Centres (FTCs) or attended demonstrations, they observed what their neighbours did and copied from them.

(Mwariri, 2003) in his study, notes a high number of respondents who had learned of technologies from research officers. This was explained by the existence of the Farmer Research External Groups (FREGs) in the study area. If FREG system was encouraged, it would also address the problem of limited diffusion and utilization of researcher findings among change agents rather than the information just remaining in the files of institutions. Some farmers get information regarding agricultural practices from extension centres. For instance seen or read KARI leaflets. (Mwariri,2003) notes that more than 68.2% in his study had read some material on rainwater harvesting while 30.8% had never read anything on rainwater harvesting. Access to mass media channels of radio, television and newspaper readership leads to higher levels of awareness, hence possible adoption, especially among innovators and early adopters.

Informal Groups are another method of dissemination of information to farmers. These include self-help groups (which may incorporate both men and women), women groups, youth groups, and men only groups which are very few. Some of the group activities include development activities such as water tank purchase or construction, land buying and purchase of household items. Institutions may perform a prime role in education and knowledge exchange, development of best practices, farmer support, and the management of RWH systems (Nijhof *et al.*, 2010) and may help provide the poorest households with resources needed for the adoption of the technologies. Farmers who attend farmers Training centres are likely to adopt rainwater harvesting technologies (Mwariri, 2003).

2.5 Factors Promoting Technology Adoption

To start with, education of farmers is one factor that contributes to adopting rainwater harvesting technologies. (Ahmed, Omwonga, Mburu, & Elhadi, 2013) notes that education level is significantly and positively related to implementation of rainwater harvesting techniques. This proposes that less-educated farmers have a lower probability of adopting water harvesting techniques, not like the more educated. Through education one is exposed to new knowledge and hence awareness is created for embracing of water harvesting techniques. In their report Chianu and Tsuji (2004) also note that in most studies on adoption, farmers with a higher education level have a possibility of practising water harvesting techniques unlike the less educated.

Ahmed *et al.*,(2013) further notes that farmers who experience water scarcity have a higher possibility of adopting rainwater harvesting techniques compared to those who have not experienced water shortage. The water scarcity is caused by the erratic and poorly distributed rainfall within the season. UNFCC (2000) notes that smallholder farmers from the dry areas of Kenya adopt water harvesting technologies because of long periods of water shortage and drought. Senkondo, *et al.*, (1999) reports that farmers with large farms may fail to adopt rainwater harvesting techniques because they already expect much harvest. Contrary, in their report, Bunyiza *et al*. (2008) noted that those farmers who had bigger farms were more likely to adopt water harvesting technologies.

Ahmed *et al.,* (2013) notes that farmers with more knowledge of rainwater harvesting techniques have got higher chances of adopting water harvesting techniques. Studies of the same kind by Herath and Tekaya, (2003) reveals that farmers who had positive attitude were more serious on practising agricultural technologies in which an element of water harvesting is integrated. Ahmed *et al.,* (2013) found out that farmers' age significantly influenced adoption of water harvesting techniques. The study indicated that there is a higher possibility for older farmers to adopt rainwater harvesting than those who are young in farming. Other studies have attributed this to the farmer's experience in farming activities.

Another factor is the distance to the water points. The distance to be covered especially by women and children to collect water for livelihood purpose contributes to awareness and need to adopt rainwater harvesting techniques (Ahmed *et al.*, 2013). Traditionally, the sources of water are located some distance from the community and therefore this creates the need to collect water and store close to the homes. This makes it convenient to access water supply, has a positive influence on health and would also strengthen the sense of ownership (Worm & Hattum, 1991)

Provision of tanks for water storage by NGOs also influences the adoption of RWH techniques. Aroka (2010) found that a number of roof water tanks had been executed by non-governmental organisations in rural areas and these tanks surpassed all in quality and increased the quantity and the availability of water at the site where they had been implemented. Rainwater harvesting too is one of the methods that can be applied in semi-arid areas to help cope with the scarce rainfall and hence enhance agricultural production. Adoption of various RWH technologies in the dry areas would bring about sustained agricultural production, which would result in improved food security in the regions (Senkondo, *et al.,* 1999). In his report, Ahmed *et al.*, (2013) found sand dams to be the second commonly practiced technique of water harvesting. They were easy to construct, could be used communally and the favorable landscape for construction contributed to adoption of the technique by farmers. In addition it provides sufficient water for plants, cattle, and people throughout the dry period.

When there is increased demand for water the reservoirs get depleted, several piped water supply fails and rainwater turns out to be an alternative. Collecting and storing water would provide water when sources such as lakes and rivers fluctuate. Worm & Hattum, (1991) notes that rainwater is also useful when the water quality is low or varies in rivers during the dry seasons. Generally rainwater is of good quality.

2.6 Benefits of Utilization of Rainwater Harvesting Technologies among Households

Rainwater harvested is used for productive purposes such as agricultural and human use. The benefits of RWH may be categorised into socio-economic and environmental benefits. In Chimvi (Zimbabwe) smallholder farmers reported some benefits of increased crop production (89%), reduction of soil erosion (87%), maintenance of fertility (82%) and introduction of new crops (77%) (Mutekwa and Kusangaya, 2006).

Wachira, (2013) similarly notes a number of benefits that results from the adoption of the rainwater harvesting technologies. These include, increased yields, increased soil fertility, reduced production costs and reduced soil erosion. In Lare Nakuru, Mati (2005) found out that adoption of ponds had enhanced the livings of the people through increased food and water security.

Rainwater harvesting in India has been a success by bringing about a positive development on human welfare and regeneration of damaged lands, mainly the semi-arid and sub-humid areas. Interventions on rainwater harvesting on farms by national watershed programs have improved household food supply and earnings. Additionally, in most cases changes such as improvements in gender and general community strengthening and organisation have been noted (‘‘Rainwater harvesting: a lifeline to human well-being,’’2009)

In Ganzu, China, millions of people have an improved water supply. Little horticulture and increased livestock and poultry keeping sustained by water harvested have contributed to having an additional income. As a result of rainwater harvesting, agriculture has become intensified and therefore less land is used for crop production. Owing to the agricultural intensification through water harvesting, a lesser land needs to be put into crop despite the population growth. The improved use of rainwater harvesting techniques offers extra water supplies and decreases pressure on surrounding water sources. In several parts of Japan and South Korea, collection and stowing of rainwater have been practised as a way to lessen susceptibility in crises, for instance earthquakes or severe flooding which can disrupt public water supplies (Rainwater harvesting: a lifeline to human well-being,''2009).

2.7 Challenges Faced by Households in Adopting Rainwater Harvesting Technologies

Low income. Low rural incomes remain to be a major obstacle for individuals wishing to invest in rainwater tanks for the household. On the other hand, among rural Africans, the collective use of impermeable thatching materials, instituting of community-based revolving funds and substantial support from certain donor agencies has helped to increase access to rainwater harvesting systems (Gould 2000). In general, the capital cost of rainwater harvesting is more expensive than gravity distributions derived from springs and hand-dug wells, but maybe less expensive than borehole water depending on depth and population density. Conversely, the maintenance cost of most rainwater harvesting systems is negligible whereas maintaining more centralized community- based systems can present a major challenge. Roof-harvested water is generally not as good as chlorinated water supplied through a well- maintained municipal system, however, if properly collected and stored, it is usually better than surface water sources and shallow groundwater sources. It is worth considering the path that contamination must take to arrive in a human being. The World Health Organisation recommends that catchment surfaces be clean, storage containers are covered and that good hygiene practice is observed (Martinson *et al*.2014).

Labour constraint is also a hindrance to the adoption of rainwater harvesting technologies. Use of rainwater harvesting practices requires much labor to manage runoff, thus lack of labour affects the ability of the families to start rainwater harvesting. (Senkondo, *et al.*, 1999) . Many RWH systems demand a high initial input, which can present problems for some families, particularly those that are extremely poor, nomadic, or headed by women (Pacey and Cullis, 1991; Kumar *et al.,* 2008), even where the willingness to replicate these systems is substantial (Nijhof et al.,2010).

In some cases the key resource that farmers lack may be the knowledge and skill to collectively manage their farmland effectively; therefore even with the provision of RWH technologies it is possible that production levels may remain low (Barron, 2009). For a well-designed rainwater harvesting system to effectively perform its function, it must be technically efficient. In rural areas many projects are not sustainable due insufficient technical interventions, for instance, to construct roof catchment systems and shallow wells, comprehensive technical instruction is required. As a result, there is poor transfer of the technological innovations and deprived managing of the project causing a greater failure rate (Wanyonyi, 2008). In Tanzania a study on rainwater harvesting technologies noted that people lacked specific knowledge in designing of water canals so as to divert water from short-lived streams, as well as knowledge to control runoff (Senkondo, *et al.*, 1999). Soil erosion and water losses also affect water harvesting where the speed of water in gullies is so high for the farmers to control it. (Senkondo, *et al.*, 1999).

2.8 Theoretical Framework

The two theories that guided the study includes; The diffusion of innovations theory by Everret Rogers that explains how, why, and at what rate new ideas and technology spread and the Technological theory by Ogburn.

2.8.1 Diffusion of Innovations Theory

According to Rogers (2003) diffusion is a way by which an innovation is communicated among the members of a community over period of time. Adoption in this theory is the decision to fully use innovation as the best course of action available and failure to adopt is a choice to reject an innovation. Diffusion takes place through a decision-making process that has five steps. It takes place over a sequence of communication networks, over a period of time among the members of the same community. The first step by which innovations diffuse is awareness. This is where an individual becomes aware of an innovation and not motivated to find out more about it. The second step is interest, whereby a person gets interested with an innovation and seeks related information about it. Step three, evaluation is when an individual chooses to adopt or reject an innovation. The fourth step is trial. This is when a person employs an innovation and may still seek to know more about it. Lastly, in step five, adoption is where an individual reflects on the decision as if to continue or not to continue with an innovation (Rogers 1995).

During or after the adoption process, a person may reject an innovation. Innovations have got five attributes. The first attribute, the relative advantage is the feeling that an idea will be better or even worse than other similar ones. The ideas believed to be better are adopted more rapidly than those thought to be worse. The second attribute, compatibility is the feeling that an object is similar and matches with the existing similar and past ideas. Those objects that fits are more easily adopted. Third attribute, complexity which entails the feeling of how difficult it is to understand an innovation. This is negatively related to adoption. Fourth attribute, triability which refers to how an idea is accessible to an individual for experimentation. In this place people get an opportunity to try out an innovation hence adoption is enabled. Finally, observability that is characterised by the availability and visibility of an innovation to a person. If more people have adopted an idea, an individual will be more likely to adopt it as well (Rogers, 1995).

The theory also explains an adopter category as the rate at which a person adopts a new idea. It outlines the five categories of adopters as; the first one innovators. These are the risk-takers, have the highest social status, usually the first to adopt an innovation which can fail eventually but is able to cope due to their financial resources. Second, early adopters. The early adopters have the highest influence among the adopter categories and socially, are far much better than the late adopters. They are so prudent in making of the choices of adoption to help maintain a central communication process. Thirdly, early majority, who are characterised by above average social status and take longer time than the innovators and early adopters to adopt an innovation. Then late majority, who are the persons who adopt an innovation after majority have adopted. They have a below average social status and are naturally skeptical about an innovation. Lastly, the laggards who are the last to adopt an idea and show little to no opinion leadership, unlike other categories. They are the lowest in social status, the lowest in financial liquidity, and the oldest among the adopters and have contact only with their family members. Laggards normally focus on traditions (Rogers, 2003).

In this study, the theory will help me to explain the process or channels of diffusion and adoption. However the theory does not adequately explain the significances of technologies adoption to society and this forms my basis for the second theory discussed below;

2.8.2 Technological Theory

Social change is influenced by many factors of which technology is one and very important factor. Change in technology brings about an equivalent change in the arrangement of social relationships. Technology is a major cause of social change which comes in three processes. The first process is invention, the second one is discovery and the last one diffusion (Ogburn, 1964). Inventions can either be material, for instance, the computer or social inventions such as bureaucracy and capitalism which have far-reaching consequences to the society. The next process is discovery which is a new way of seeing reality (Vago, 1992). It is only when a discovery comes at the right time that brings about an extensive change.

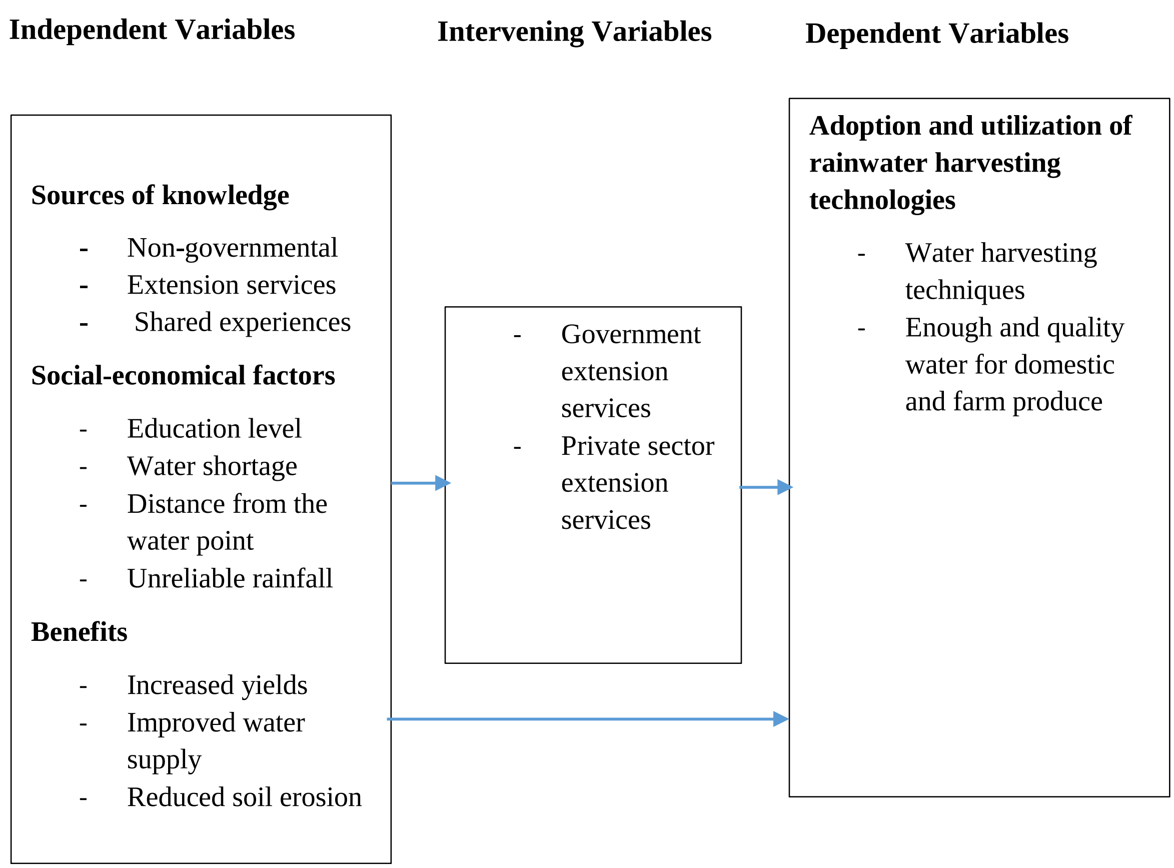
Diffusion is the third process of social change and is defined as the spread of invention or discovery from one area to another (Henslin, 1998). In this theory, diffusion is viewed as the major process of social change and contends that it can have far-reaching relationships on human relationships. Further Ogburn invented the term cultural lag to denote how some elements of culture adapt to an invention or discovery more rapidly than others. He advocated that technology changes first then culture. We, therefore, play catch-up with changing technology, to meet its needs.

This theory explains some of the behaviour patterns and cultural changes that occur to the adopters of technologies. Adoption of new technologies is a force that enhances social and economic interaction.

2.9 Conceptual Framework

A conceptual framework is an interrelated set of ideas about how a specific phenomenon functions or is related to its parts. It serves as the basis for understanding the fundamental patterns of interconnections across events, ideas, observations, concepts, knowledge, interpretations, and components of experience. The conceptual framework shows how reality works (Svinicki, 2010). In a statistical perspective, the conceptual framework describes the relationship between the main concepts of a study. It is arranged consistently to help show a visual display of how ideas in a study relate to one another (Grant & Onsloo, 2014) (Adom & Joe, 2018).

Figure 2.2: Conceptual Framework



CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter summarises the research methodology that was used in order to find the answers for the research questions. This chapter includes the research design, target population, sampling technique, and sample size, tools of data collection, the reliability and the validity of data collection.

3.2 Site Description

Mbeere North Sub-County of Embu County is found in the South eastern slopes of Mt.Kenya. It is found between latitude 0.9672 S and 0.47330 S, and between longitude 37.47680 E and 37.91238 E. It covers an area of 744.80 sq.km and has population of 89035. On the other hand, Evurore ward covers an area of 409.9 sq. km with a population of about 45,582 (KNBS, 2009). Mbeere people live on the lower side of Embu which receives relatively low rainfall. They grow cash crops like Cotton, and food crops such as maize, beans, cowpeas, pigeon peas, and green grams. Temperatures ranges from 20ºcCto 30ºC. The coldest month is July with an average monthly temperature of 15ºC and the warmest month is September with an average monthly temperature raising to 27.10ºC. The area experiences two different rain seasons with a bi-modal rainfall pattern. One season is between March and June when the long rains are experienced and the other one is between October and December when the short rains are experienced (County Integrated Development Plan, 2017).

3.3 Research Design

This research used a descriptive survey design for data collection. It was used because it helps to describe the state of affairs as it exists at present (Baxter, Hastings, Law, & Glass, 2008). The design investigated the causal factors of household adoption and the use of rainwater harvesting technologies in Evurore ward, Mbeere North Sub-County. This design was important because it enabled to gather evidence related to the problem of study to determine the status of the phenomenon under investigation by applying personal contact and interviews. The design enabled the researcher accommodate a large sample size which is a prerequisite in the generalization of results.

3.4 Unit of Analysis

The unit of analysis refers to the main object that is being analysed in a study. In this study, the unit of analysis was the factors that influence household adoption and the utilisation of rainwater harvesting technologies in Evurore Ward, Mbeere North Sub-county.

3.5 Units of Observation

The unit of observation is an object about which information is collected. The units of observation in this study was the male and female household heads and or active participants in water harvesting from the two locations; Muringari and Kiang'ombe of the study area together with the key informants and the focus group discussants.

3.6 Target Population

A population refers to all items put into consideration in any field of investigation. In statistics it is represented by N. In this study, the study population was defined as all individuals in the two locations that make up Evurore Ward who are in engaged in water harvesting and making use of it. The study targeted the male and female household heads and or active participants in the farm system.

3.7 Sample Size

The study sample size was 114 (n) which represented 15% of 760 (N) farmers from the list obtained from the Ward Agricultural officer. According to Mugenda and Mugenda (1999) for descriptive studies, 10% to 20% of the target population is adequate for a sample.

3.8 Sampling

A sample refers to a representation of a part of a population and usually represented by n. According to Giddens (2008), sociologists engage sampling i.e. small proportion of the overall group in order to study it and make a generalization of results about the population from which they were chosen. I selected two locations: Kiang'ombe and Muringari which are in the lower drier zone of Evurore Ward and practice water harvesting. I obtained the list of the households practising water harvesting techniques from the Ward Agricultural Officer. The list had 760 (N) farmers. In order to select the sample, an interval of six was dertermined using the formulae below;

Interval (I) = N/n where;

N is total population and n is the sample size.

$$\text{Interval} = \frac{\text{760 total population}}{\text{114 sample size}} = 6$$

Thereafter systematic sampling was used to select farmers who were interviewed at household level.

3.9 Methods of Data Collection

This study employed both qualitative and quantitative methods of data collection. The methods of data collection were triangulated to ensure the validity of the data collected and the analysis. Primary data was gotten through face to face interview. This aided to explain or clarify questions to the respondents.

3.9.1 Key Informant Interviews

A key informant is a knowledgeable source of specific information (Marshall, 1996). In this study factors influencing doption and utilisation of rainwater harvesting technologies, they filled the information gaps that the researcher had with regards to the research area. Key informants give a particular perspective or communicate specific challenges the particular group in a community are facing. Six Key informants who were extension officers working in Evurore ward, Mbeere north sub-county were purposefully sampled. They comprised of field officers who work closely with the farmers.

3.9.2 Household Survey

Survey method includes any measurement procedures that involve asking questions to the respondents. It consists of both closed and open-ended questionnaires meant to capture relevant and significant information. In this study, household interviews were conducted using a structured questionnaire to establish the farmers' opinion on adoption and utilisation of rainwater harvesting.

3.9.3 Focus Group Discussion

A focus group discussion entails a group of people with certain characteristics who come together to discuss a given topic (Anderson, 1990). It is used to collect qualitative data for in-depth understanding of social issues. In the discussion, a moderator introduces the topic and guides the participants through the discussion. In this study focus group discussion was done with four different groups of farmers, two in each location. Two for youth farmers 18-35 (one for male youth and one for female youth). The other two were for adult women and men farmers. The researcher used only four groups for FGDs to optimise on the available time and the groups were homogenous to allow free expression hence more focused results. The researcher facilitated the discussion as her two undergraduate assistants helped in taking of the notes. The use of two assistants was to ensure no information is lost. After the FGD the notes of the two assistants were compared and one set of notes compiled for each FGD. The participants in each FGD were 10 and each FGD lasted a maximum of one hour.

3.9.4 Secondary Data

Secondary sources of data such as journals, newspaper, review books, research reports, scientific magazines, websites, and other documentations were used. This enhanced the field report.

3.10 Tools of Data Collection

3.10.1 Key Informant Interview Guide

Key informant interview guide is a research tool administered on key informants to enable in-depth discussion of the issues under investigation. The KIG had discussion topics that guided the discussions.

3.10.2 Questionnaire

A questionnaire is a tool containing a series of questions with the purpose of gathering information from respondents. A questionnaire measures separate variables and with questions that are aggregated in index scale. The researcher administered questionnaires to the head of household on spot. The questionnaire had quantitative questions. In several sections, the questionnaire focused on different issues that address the research objectives. It was administered face to face.

3.10.3 Focused Group Discussion Guide

It entailed a list of discussion topics about the objectives of the study.

3.11 Pre-test

A pre-test of tools was undertaken. The purpose was to test the relevance of the tools. The results of the pre-test were used to adjust the tools and planning for the data collection.

3.12 Validity

It is about what an instrument measures and how well it does so (Personal, Archive, & Mohajan, 2017). The validity of the research instrument was checked by critically assessing the questions to avoid ambiguity. In addition, the validity was ensured by undertaking the pilot test. The researcher too subjected the tools to peer review. Only the questions which met threshold that were used to complete the instrument.

3.13 Ethical Consideration

Ethics are standards of behaviour that guide one's moral choice about their behaviour and relationship with others. Kothari (2004), notes that the goals of ethics in research are to make sure that no one suffers adverse consequences from research activities. Similarly, Mugenda (2011) encourages protection of the welfare of participants. These include the right to life, protection from pain and injury.

The study observed the ethical issues governing the rights of participants in the research. To achieve this, the researcher sought consent from relent authorities and maintained confidentiality, anonymity, and respect in handling the information obtained from the respondents.

Permits authorization letters were sought to grant permission to access the study site. The researcher obtained a letter of authorization from the Department of Sociology before commencing data collection. I also introduced myself to the Agricultural officer and chiefs.

The participants were notified of nature and data collection procedure. Information contained in the consent was to request the respondents to provide relevant information willingly and voluntarily, also the researcher highly esteemed the opinions and views of those who failed to unveil certain information.

Prior to the issuance of the informed consent, the participants were notified on the precautions to be taken in order to safeguard the data obtained and notified of the parties who may access the information. Respondents were coded by the researcher and none was allowed to give their personal details. These ensured honesty in the collection of adequate and reliable information since the respondents were assured of their confidentiality.

The researcher allowed anonymity whereby the respondents gave information without identifying themselves. Codes were developed by the researcher to identify the respondents. This was to prevent the undue exposure of the respondents and help overcome biases.

3.14 Data Analysis

The quantitative data were analysed using Statistical Package for Social Sciences (SPSS). The descriptive statistics was computed and data presented using tables. Qualitative data was analysed using the ATLAS and presented through quotations.

CHAPTER FOUR

DATA PRESENTATION AND FINDINGS

4.1 Introduction

The analysis and interpretation of the data findings are presented in this chapter. It starts with the respondent's demographic information followed by analysis of sources of knowledge for rainwater harvesting technologies, the next section covers factors that promote technology adoption, the third section devoted to benefits of utilization of rainwater harvesting, the chapter finally presents challenges in adoption. Results were presented in figures and tables with frequencies and percentages.

4.2 Respondents Demographic Information

4.2.1 Respondents Social and Administrative Location

A total of 114 respondents interviewed in the study with 61 (53.5%) form Muringari location and 53 (46.5%) from Kiang'ombe location, as shown in Table 4.1.

Table 4.1: Administrative Locations

Location	No.	Percent (%)
Kiang'ombe	53	46.5
Muringari	61	53.5
Grand Total	114	100

They were residents of the following sub-locations: Kamumu 61(53.5%), Kariru 30 (26.3%). A small proportion of 23 (20.2%) of those interviewed came from Kathera sub-location, as shown in Table 4.2.

Table 4.2: Sub-location

Sub-location	No.	Percent (%)
Kathera	23	20.2
Kariru	30	26.3
Kamumu	61	53.5
Grand Total	114	100

4.2.2 Gender

The gender composition of the respondents was Male 54 (47%) and females 61 (53%). This shows that both male and females are farmers. More female were found at home at the time of the interview.

4.2.3 Age Distribution

The Age distribution for the respondents was: 18-25 years 6(5%), 26-32 years 17(15%), 33-40 years 18 (16%), 41-47 years 19 (17%), 48-55 years 28 (25%). Among those interviewed, 26 (23%) were above 56 years. This shows that farmers are both youth farmers and adult farmers.

Table 4.3: Age Distribution

Age Distribution	No.	Percent (%)
18-25 years	6	5.2
26-32 years	17	14.9
33-40 years	18	15.8
41-47 years	19	16.7
48-55 years	28	24.6
over 56 years	26	22.8
Grand Total	114	100

4.2.4 Education Attainment

The education attainment of the respondents was as follows; No education 9 (8.0%), Primary education 66 (57.8) %, Secondary education 20 (17.5%), post-secondary education 7 (6.1) % and those with university education 12 (10.5%) as shown in Table 4.4. Therefore the lower the level of education the more likely that one will be involved in crop farming.

Table 4.4: Education Attainment

Level of Education	No	%
No education	9	8.0
Primary	66	57.9
Secondary	20	17.5
Post-secondary	7	6.1
University	12	10.5
Grand Total	114	100

4.2.5 Religion

Most farmers were; christians 112 (98%) and 2 (2%) were members of traditional religion.

4.2.6 Marital Status

The marital status of the respondents was married 91 (81%), widows(er) 14 (12%), Single 5 (4%). Only 2 (1.8%) were divorced.

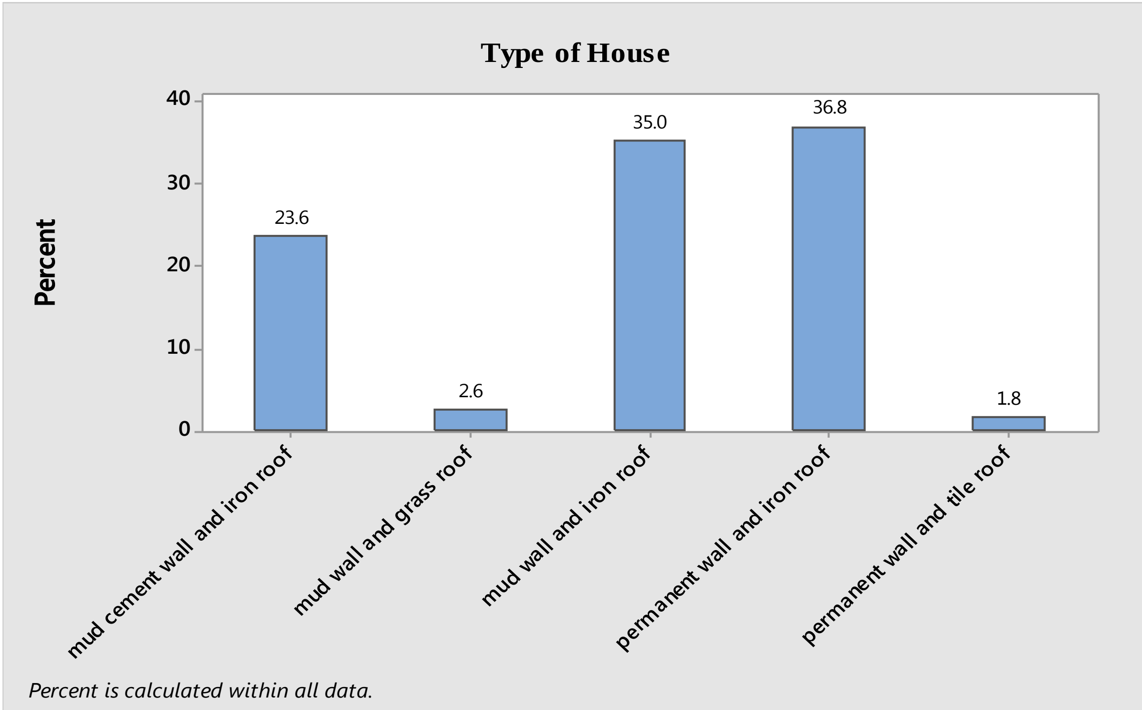
The average household size in the study area was 5 members.

4.2.7 Type of Houses

Most of the respondents had houses with permanent wall and iron roof 42 (37%), mud wall and iron roof 40 (35%), mud cement wall and iron roof 27 (24%), mud wall and grass roof 3 (3%), and permanent wall and tile roof 2 (2%) as shown in Figure 4. 1. This implied that a bigger number of the respondents practiced rainwater harvesting as most of them had impermeable roofing.

Figure 4.1: Type of Houses

n=114



4.2.8 Household Monthly Income

Most respondents 41 (37%) earn a monthly income of less than Khs.10, 000, 32 (29%) earned 10001 to 20,000, 19 (17%) earned 20,001 to 30,000, 9 (8%) earned 30,000 to 40,000. Those who earned above 40,000 constituted 11(10%) of the total respondents. The results imply that most of the respondents are low-income earners.

According to the results of FGDs and Key informants, the key sources of income in the area of study are agricultural produce: sale of sorghum, maize, beans, mirra, cowpeas, millet, and livestock. However maize was the main source of household income for most farmers but mirra farmers (5.2) receive the highest income. In addition mirra farmers receive income on a daily basis unlike other farmers who receive seasonal basis.

Table 4.5: Monthly Income Level

Monthly Income	No.	Percent (%)
Less than 10,000	41	36.6
10,001-20,000	32	28.6
20,000-30,000	19	17.0
30,000-40,000	9	8.0
Above 40,000	11	9.8
Total	112	100

4.2.9 Ownership of Livestock

The types of livestock owned by the respondents were as follows; poultry 86 (51.5%), Goat/sheep 57 (34.2%) while those who owned cattle were 24 (14.3%). The low and unreliable rainfall in the area is conducive for poultry and sheep/goat keeping but it is not conducive for cattle keeping.

Table 4.6: Livestock Ownership

n=167

Livestock owned	No.	Percent (%)
Cattle	24	14.3
Goat/Sheep	57	34.2
Poultry	86	51.5

4.2.10 Household Land Size

A majority of respondents 61 (53.5%) had 3-5 acres land, followed by those with less than 2 acres 29 (25.4%). Only, 24 (21%) had a land size that are over 5 acres.

Table 4.7: Household Land Size

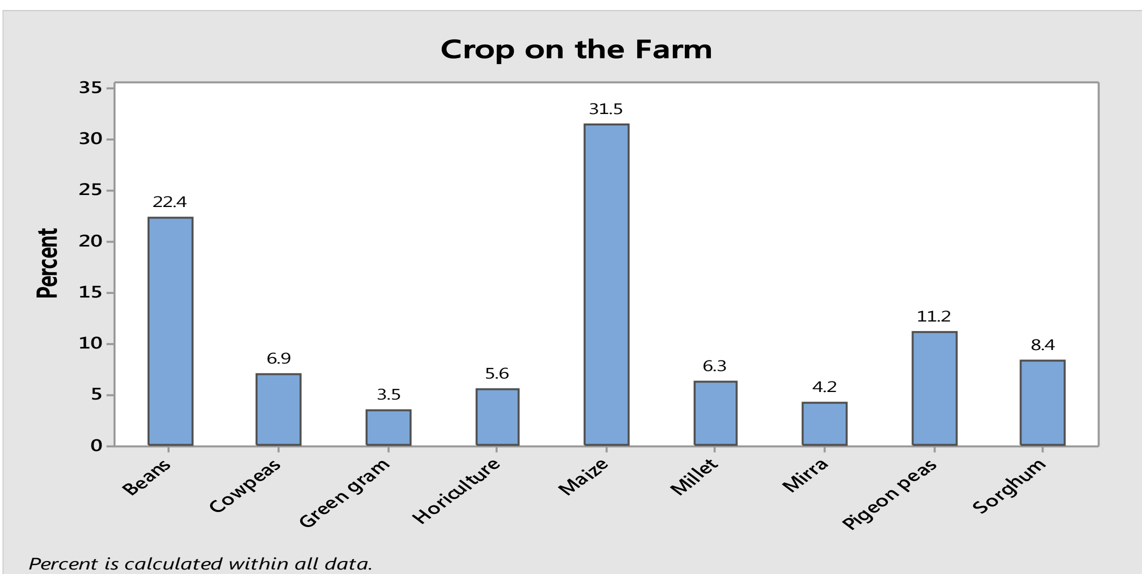
Size of Land	No.	Percent (%)
0-2 Acres	29	25.4
3-5 Acres	61	53.5
over 5 Acres	24	21.1
Grand Total	114	100.0

4.2.11 Crops on the Farm

The most commonly planted crops on the respondents farms were: maize (36) 31.5%, beans (25) 22.4%, pigeon peas (13) 11.2%, and sorghum (10) 8.4%. Other crops include cowpeas (8) 6.9%, horticulture (6) 5.6%, millet (7) 6.3%, green gram (4) 3.5% as well as mirra (5) 4.2%. Discussions with the key informants and information from FGDs confirmed that those are the commonly planted crops in the research area. They further said that maize, pigeon peas, sorghum, cowpeas, and green grams are planted as cash crops but also for domestic consumption. Miraa is a recent crop introduced about 10 years ago but it has rapidly spread. The distribution is shown in Figure 4.2.

Figure 4.2: Crops on the Farm

n=114



4.2.12 Water Harvesting Technologies on the Farm

All the respondents in the study area harvest water in their farms. The study results showed that the common technologies on the farm are; stone bunds 35 (44%), 21 (26.3%) use terracing, 9 (11.2%) mulching, 6 (7.5%) piped water, 4 (5%) river water, 4 (5%) dam/water pan as water harvesting technologies. Only 1.3% of those interviewed use concrete tanks as shown in table 4.8. A key informant from the County also noted the following as some of the techniques used in the farm; water pans, Zai pit, rock catchment, surface, and subsurface dams. Malesu *et al.,* (2007) notes that ponds, pans, and dams are found throughout Kenya and further illustrates that the water pans have traditionally been used in several parts of Kenya. In regards to installation and maintenance cost, dam/water was cited by 55 (48.2%) of the respondents to be the most expensive, followed by terracing 32 (28.1%), and stone bunds 14 (12.3%), while mulching 13 (11.4%) was the least expensive method.

Table 4.8: Type of water harvesting technologies on the farm

Type of technology	No.	Percent (%)
Concrete tank	1	1.3
Harvest of water from the river	4	5
Mulching	9	11.2
Dam/Water pans	4	5
Piped water	6	7.5
Stone bunds	35	44
Terracing	21	26.3
Grand Total	80	100

A total of 25% of the respondents use irrigation on their farms and most of them said they began irrigation less than 4 years ago. It was established that the use of irrigation was promoted by a non-governmental organisation with programmes in the area. However a key informant said that most irrgation in the project area was an initiative of the ministry of the Agriculture supported by the International Fund for Agricultural and Development (IFAD).

For those that have farm crops under irrigation, they mentioned the following crops; bananas 1 (1.1%), potatoes 3 (3.3%), miraa 9 (8.8%), mangoes 12 (13%), spinach 15 (16.3%), tomatoes 18 (20.6%) and kales 34 (37.0%).

Table 4.9: Crops under Irrigation (Multiple Select)

n=92

Crop under Irrigation	No.	Percent (%)
Bananas	1	1.0
Potatoes	3	3.3
Mirra	9	8.8
Mangoes	12	13.0
Spinach	15	16.3
Tomatoes	18	20.6
Kales	34	37.0
Grand Total	92	100

4.2.13 Duration of Farming

Majority of respondent 63.9% have been farmers for more than 10 years, while 21.6% have been farmers for 5 to 10 years. Only 14.4% have been farmers for less than 5 years. The differences in duration of farming are due to the fact that some farmers are youth who began farming only recently.

4.2.14 Water Harvesting for Domestic Use

From the study area, a total of 53.2% of the respondents harvest water for domestic use. The technologies for domestic water harvesting used by respondents were as follows; Gutters on the roof 88.4%, Concrete water tank 18.3%, Plastic Water tank 81.2%, Metallic water tank 10.4% and Underground water tank 18%.

Table 4.10: Type of technology for domestic water harvesting

n=114

Type of technology	No (n)	Yes (%)	No (n)	No (%)	Total (n)	Total %
Gutters on the roof	101	88.4	13	11.6	114	100
Concrete water tank	21	18.3	93	81.7	114	100
Plastic Water tank	93	81.2	21	18.8	114	100
Metallic water tank	12	10.4	102	89.6	114	100
Underground water tank	21	18	93	82	114	100

4.2.15 Duration for Using Roof Water

At the time of the interview, 61 (59.2%) of the respondents had the harvested water in the container and 42 (40.8%) had already used up the harvested water. For those respondents that have been using roof water, 68 (63%) have practiced it for more than 10 years, 22 (20.4%) have been using roof catchment between 5 to 10 years and only 18 (16.6%) have been practicing the technology for less than 5 years as illustrated in Table 4.11.

Table 4.11: Duration for Using Roof water

Duration	No.	Percent (%)
Less than 5 years	22	20.4
5-10 years	18	16.7
over 10 years	68	63.0
Grand Total	108	100

4.2.16 The Quantity of Rainwater Harvested per Season

Most of the respondents harvested less than 5000 litres of rainwater (60.4%), while a considerable proportion harvested between 5000 and 10,000 litres (24.3%). Only 17(15.3%) harvested more than 10,000 litres of rainwater.

Table 4.12: Quantity of rainwater harvested per season

Quantity harvested	No.	Percent (%)
Less than 5000 litres	67	60.4
6000-10000 litres	27	24.3
More than 10000 litres	17	15.3
Grand Total	111	100

The findings of the study showed that most respondents 51 (44.7%) used the harvested rainwater for less than 2 months and 34 (29.8%) for more than 5 months. Also, a substantial proportion of 29 (25.4%) used the rainwater for periods between 3 to 5 months as presented in Table 4.13.

Table 4.13: Duration for Rainwater Household use

Duration	No.	Percentage (%)
0 – 2 months	51	44.7
3 – 5 months	29	25.5
Over 5 months	34	29.8
Grand Total	114	100

In the study area, the cost of acquiring roof water harvesting equipment was between Ksh.10, 000 - Ksh. 20,000 for 49 (43%) of respondents and less than 10,000 for 35 (30.7%) of the respondents. A number of respondents 30 (26.3%) purchased the equipment at a cost of more than Ksh.30, 000.

Table 4.14: Cost of Acquiring Roof Water Harvesting Equipment

Costs Ksh.	No.	Percent (%)
0-10000	35	30.7
10000-20000	49	43.0
Over 20000	30	26.3
Grand Total	114	100

For those that installed the roof water harvesting technology, 69 (60.5%) used local technicians, 30 (26.3) installed themselves, 8 (7%) employed hardware staff, and 7 (6.1%) used agricultural extension officer.

Table 4.15: Person In-charge of Installation

	No.	Percent (%)
Agriculture extension officer	7	6.1
hardware staff	8	7.0
Myself	30	26.3
Local technician	69	60.5
Grand Total	114	100

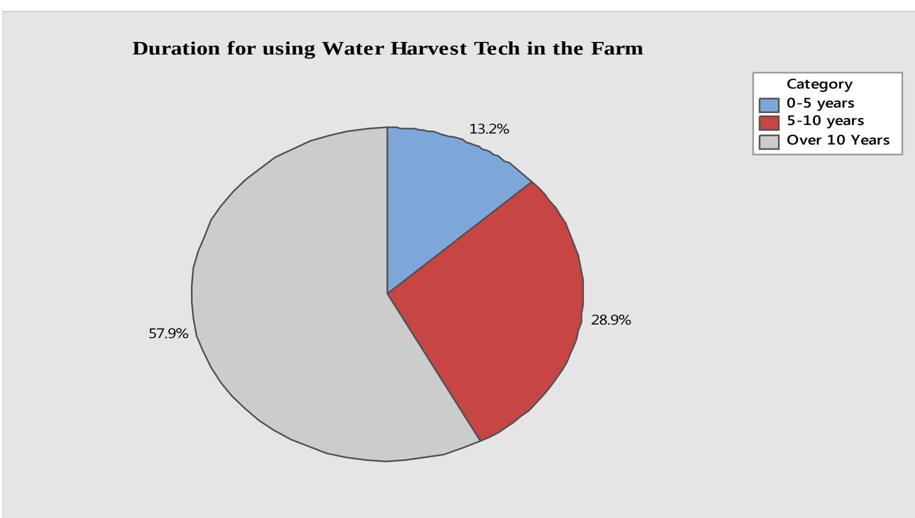
4.2.17 Cost of Installing Water Harvesting Technique

In regards to costs for installing water harvesting technology, the costs ranged between Kshs.24, 200, and Kshs. 200,000.

In terms of duration for using the water harvesting technology in farms, a majority of those interviewed (66) 57.9% have used the technology for more than 10 years followed by (33) 28.9% who have practiced the technique for between 5 and 10 years. Only (15) 13.2% have used the technique for less than 5 years.

Figure 4.3: Duration for Using Water Harvest Techniques in Farms

n=114



4.3 Sources of Knowledge for Water Harvesting

Objective one of the study was to find out the sources of knowledge for water harvesting technologies. The study found out that 45 (39.5%) of respondents obtained information about rainwater harvesting technologies for domestic use from public health officers, from agricultural extension officers 22 (19.3%), from seminar attended 22 (19.3%) and from their neighbor 22 (19.3%). Only 3 (2.7%) obtained information from a local hardware technician. Information obtained from qualitative sources confirmed that knowledge for rainwater harvesting technologies was obtained from several sources in the sub-county. A key informant, an agricultural officer attributes:

> *‘‘ In this area, farmers obtained knowledge on water harvesting techniques from seminars organized by NGOs and the Ministry of Agriculture, from their neighbours, chief's baraza and agricultural shows.’’*

Prackash (2011) notes that rainwater harvesting training offers instructions on the concept and technology of rainwater harvesting for domestic use. The trainings entail water optimization, common rainwater harvesting systems, selection of appropriate rainwater harvesting technology, storing methods and contaminants in rainwater harvesting system.

Table 4.16: Source of knowledge for rainwater harvesting for domestic use

Source of Information	No.	Percent (%)
Agricultural extension officer	22	19.3
Neighbour	22	19.3
Hardware	3	2.7
Public health officer	45	39.4
Seminar	22	19.3
Grand Total	114	100

4.3.1 Source of Information for Water Harvest for Farm Use

The sources of information for water harvesting for farm use were: Agricultural extension officer (56) 49.1%, a seminar attended (14) 12.2%, and chief's Barraza (14)12.3%. Other sources of information included: public health officer (7) 6.1%, those who read about it were (11) 9.6% while those who heard from a neighbour were (11) 9.6%. Only 0.8% received information from the local hardware. Key informant reports show that some farmers learned about rainwater from study tours where they visit other places. This agrees with Star (2018) that reported that a number of Members of parliament from Murang'a had visited Kenyatta village in Yatta constituency to learn about water pans.

Black *et al*, (2012) found attending training, conferences, workshops, seminars, field trips and exposure visits as a way of capacity building of the target recipients whereby the local people are enlightened on how to make use of the water bodies without contaminating them. Also Mwariri (2003) in a study on the diffusion of small scale rainwater harvesting technologies in the arid and semi-arid areas of Nakuru reveals that though some farmers did not visit farmers' training, they observed and copied what their neighbors did.
In addition, the average number of water technologies installed on farms was 2 with the maximum number of technologies installed being 5.

Figure 4.4: Source of Information for Water harvest for farm use

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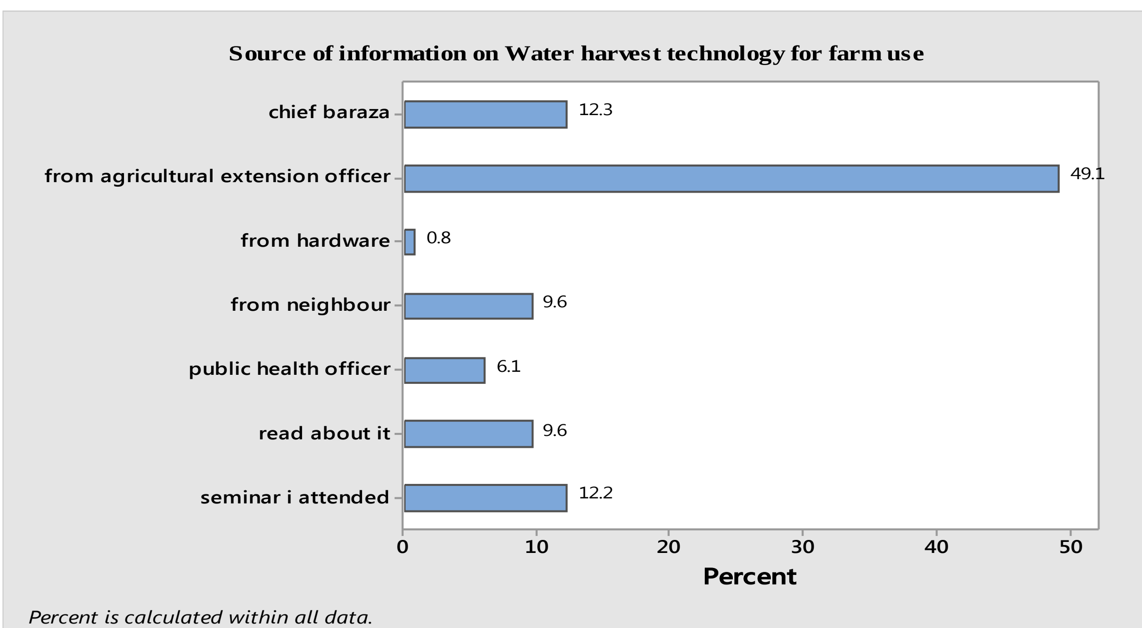

4.3.2 Source of Labour for Installing Farm Technologies

The findings of the study show that Source of labour installation of water harvesting technologies in the farm included: paid labour 53 (46.5%), followed by 34 (29.8%) who erected and maintained the technology by themselves, and Household-joint labourer 27 (23.7%). Murgor (2013) notes some limitations in adopting modern technologies and inputs. These include; Very high cost of hired labour, high transportation cost for agricultural products, high cost of construction materials and lack of credit access or shortage of capital.

Table 4.17: Sources of Labour for Installation of Water harvesting technologies

	No.	Percent (%)
Household-Joint Labour	27	23.7
Paid labourer	53	46.5
Self	34	29.8
Grand Total	114	100

4.3.3 Advantages of the Farm Technologies Used for Water Harvesting

The most mentioned advantage of the chosen water harvesting technologies in the farm was the fact that they were easy to maintain (63) 55.3%, followed by technology affordability (30) 26.3% and less labour to install and maintain (21) 18.4%. Qualitative information showed that rainwater harvesting technologies in the farms help prevent much runoff hence controlled soil erosion and too boosted the soil moisture that even when the rain is scarce the crops are not very much affected by the scorching heat. One female adult farmer noted as follows:

> *‘ Since I began implementing water harvesting technologies on my farm,
> I have managed to control soil erosion.’*

Table 4.18: Advantages of the Farm technologies used for water harvesting

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Advantage	No	%
Affordable	30	26.3
Easy to maintain	63	55.3
Require less labour	21	18.4
Grand Total	114	100

The disadvantages raised by respondents were: High costs associated with procuring and installing the technologies 39 (34.2%), frequency maintenances 37 (32.5%) and vulnerable to floods 21 (18.4%) as well as labour intensive 17 (14.9%).

4.4 Factors that Encourage the Adoption of Rainwater Harvesting Technologies

A number of factors were found to promote adoption of rainwater harvesting. They are discussed below.

4.4.1 Roof Water Harvesting Technique

The study sought to establish why respondents decided to install roof water harvesting for domestic use. Majority of those interviewed cited presence of iron roof in their homestead 38 (33.3%), followed by 36 (31.6%) of the respondent who said that the source of the river is far. A number of respondents 36 (31.6%) reported having obtained information about quality roof water from public health which contributed to the adoption. Those who were convinced by neighbour constituted 9 (7.9%) of those interviewed. Ahmed *et al.,* (2003) notes that the distance covered by women and children to collect water for livelihood purposes greatly contributes to the need for embracing rainwater harvesting technologies. On the other hand, Kahinda *et al*, (2007) notes one advantage of RWH as that of providing water close to the homes and hence lowering the covered for water collection.

Majority of the respondents (98) 86% use roof water while (16) 14% depend on river water as displayed in Figure 4.6. Discussions with the key informants showed that roof water was clean and therefore preferred by most people in the study.

Figure 4.5: Comparison between roof water and river water

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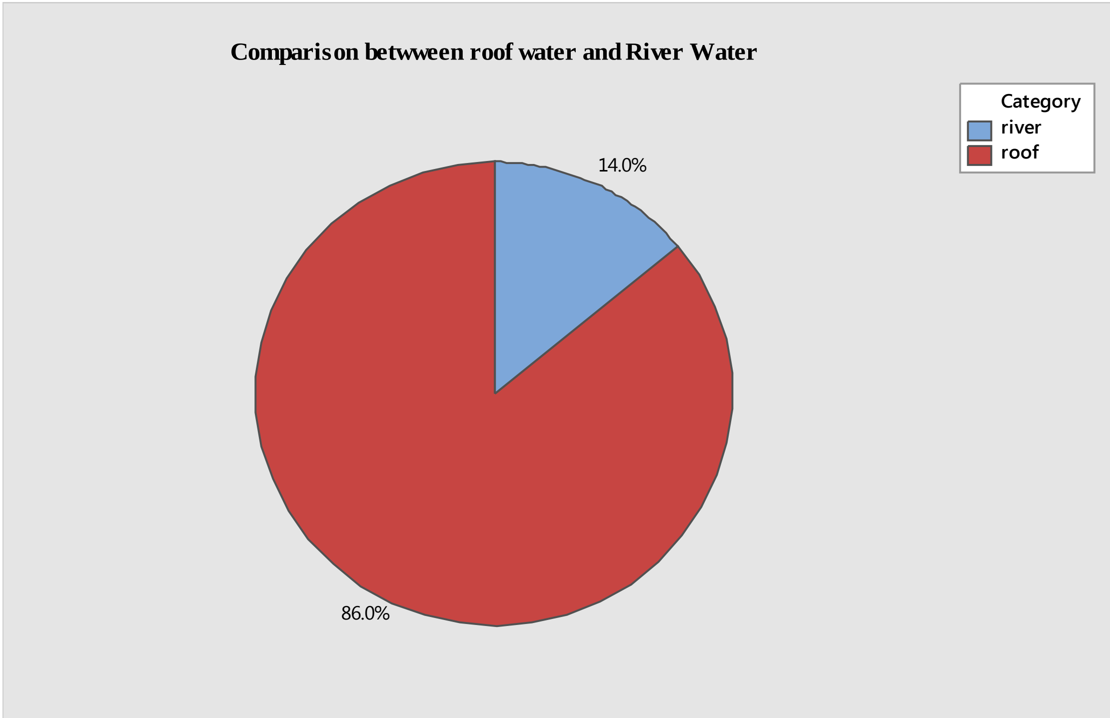

4.4.2 Local Associations

From the study, most respondents 71 (62.3%) were members of a local group. Only 43 (37.7%) were not subscribed to any local association. For those that were in a local association, 64 (60.95%) indicated that it enabled them to buy a water tank. 41 (39.05%) alludes that the local group exposed them to information they were not aware of. This infers that more members in the study area belong to an informal group. A significant proportion of 102 (94.5%) of respondents reported that those in the group have a majority of water tanks as compared to those not in the group. Only 2 (5.5%) claimed that those not in the group have a lot of tanks. Further, Majority of respondents 106 (93%) think that being in a group has helped them to have roof water harvesting equipment. Only 8 (7%) reported not having benefited from the group in regards to acquiring the equipment. Also, those who think that not being in the local group would have not secured them a chance of having the roof water harvesting equipment were 102 (91%). Only 12 (9%) were of a different opinion.

From the FGD, the researcher noted that most people in the study area have bought tanks through contributions made in the families get together. A female youth farmer said:

> *'In my family, we always have a get-together and here we contribute for the host, and this has enabled most of our members to purchase water tanks and the house items.'*

In addition, the study noted that some of the farmers from the study area had received water tanks as donations from the NGOs i.e. Compassion International, an organisation that supports the needy children in the area.

Benefits from the Local Associations

In terms of benefits from the local association, a majority 50 (48.1%) reported that the group enabled them to contribute for each member to be able to purchase the equipment followed by 28 (26.9%) who reported that the group enabled them to accumulate their saving to purchase the equipment. Also, a substantial proportion of 26 (25%) of those interviewed cited that the group enabled them to obtain loans. Nijhof *et al*., (2010) notes informal groups as a method of dissemination of information to farmers and supports some of the group development activities such as water tank purchase or construction, land buying and purchase of household items.

Table 4.19: Benefits of Local Associations

Benefits of Local Associations	No.	Percent (%)
Enable to accumulate saving	28	26.9
Obtain a loan	26	25.0
The contribution made to each memb	50	48.1
Grand Total	104	100

4.4.3 Adoption of Water Harvesting Technologies in the Farms

Most respondents 45 (39.5%) were influenced to adopt water harvesting technologies in their farms after hearing about its long term benefit from those practicing the technology. A considerable number of respondents 29 (25.4%) adopted the technology because of its low initial cost. Other influences were labour requirements which were affordable 14 (12.3%) as well as the severity of soil erosion in their farms 26 (22.8%). Further, the majority of respondents 77 (68.8%) were influenced as a second thought to adopt water harvesting technology in their farms because of the desire to increase food production. 28 (25%) revealed that the adoption of technologies would increase their income. Only 7 (6.3%) desired to initiate irrigation in their farms as indicated in Table 4.20.

Table 4.20: Influence to adopt water harvest technique in the farm

Influence to adopt	No.	Percent (%)
The desire to increase food production	77	68.8
The desire to undertake irrigation	7	6.2
To increase my income like my neighbor	28	25.0
Grand Total	112	100

4.4.4 Factor Productivity Before and After Using Water Harvest Technology

There was a significant increase in the production of maize, beans, sorghum, millet, peas, and miraa after respondents used water harvesting techniques. From the focused group discussion, it was reported that there was much increase in food crops production and too, those farmers who grew miraa though few, reported good harvest unlike before adoption and were far much ahead of others in terms of the income earned.

Table 4.21: Quantity of Production before and After Using the Technology

Quantity of Production	Average Before using the Technology (Kgs)	Average After using the Technology (Kgs)	% Increase
Maize	850	1700	50
Beans	350	1200	71
Green grams	280	1100	75
Cowpeas	145	210	31
Pigeon Peas	107	245	56
Sorghum	110	330	67
Millet	540	760	29
Mirra	70	190	63

4.4.5 Income Before and After Using Farm Water Harvest Technology

There is a significant increase in income for maize, beans, sorghum, millet, peas, and Mirra after respondents used the water harvesting techniques in their farm Table 4.22 show the matrix.

Table 4.22: Income per season before and After Using the Technology

Average Income	Average Income earned before using the Technology (Ksh)	Average Income earned After using the Technology (Ksh)	% increase
Maize	25,550	51,000	50
Beans	21,000	71,000	70.4
Green grams	18,000	35,000	48.6
Cow peas	10,100	26,000	61.2
Pigeon Peas	12,000	33,000	63.6
Sorghum	15,000	29,000	48.3
Millet	14,000	28,500	51
Mirra	14,600	20,700	29.5

4.5 Benefits of Rainwater Harvesting to the Household

4.5.1 Roof Catchment for the Household

Most respondent (33) 29.0% cited clean water as a benefit of roof water catchment, followed by (30) 26.3% who felt that using the technology presented no direct cost implication. Also, a substantial proportion (29) 25.4% of those interviewed reported that roof water catchment requires fewer efforts to procure. Also, (22) 19.3% reported that water obtained from roof catchment method is safe for consumption as shown in Table 4.23. Goyal (2014) notes that rainwater harvested provides a renewable source of clean water, involves low cost, it is accessible and easily maintained. Water harvested can be used for garden watering, domestic purposes, small scale farming and also aid in reducing flood risks.

Table 4.23: Benefits of roof water catchment for the household

Benefits of roof water	No	%
Cleaner	33	29.0
Less energy used	29	25.4
No direct cost implication	30	26.3
No need to treat	22	19.3
Grand Total	114	100

Specific benefits to household members were: Household member spends most of their time doing other important activities 58 (50.8%), Children have more time to study and play since they do not fetch at far way places 20 (17.5%). Also, there no further costs incurred such as treating the water 19 (16.7%), Spouse does not get tired going far away to fetch water 15 (13.4%), Lastly, 2 (1.8%) of those interviewed reported that the technique saves fuel that could have been used to boil water. Table 4.24 presents the findings. Reports from FGDs reveals that those farmers who had adopted Rainwater Harvesting Technologies had an added advantage of selling water to other non-adopters or to those who harvest in little amount, one male youth from the group noted:

> *‘‘Those who are in a position to harvest much water sell to others and otherwise save the cost of buying water themselves’’*

Table 4.24: Specific Benefits of Roof water catchment

	No.	Percent (%)
Children have more time to study and play	20	17.5
Most time to do other things	58	50.8
Spouse (wife) does not get tired	15	13.2
No cost for water treatment	19	16.7
save fuel for boiling	2	1.8
Grand Total	114	100

Most respondents (53) 46.5% cited increased farm harvests, followed by (41) 36% who reported improved food security. Also, (20) 17.5% claimed that water harvesting technologies have increased their income earners. This agrees with a study by Wichita, (2013) who reports a number of benefits that comes with adoption of the rainwater harvesting technologies. These included; increased yields, increased soil fertility, reduced production costs and reduced soil erosion. A key informant, an official from the Embed County water offices also agrees with this. He alluded that:

> *''Some of the benefits for rainwater harvesting are; Access to water throughout the year, better incomes from agricultural products and increased harvest''.*

Results are shown in Figure 4.6.

Figure 4.6: Benefits of Water harvesting technologies

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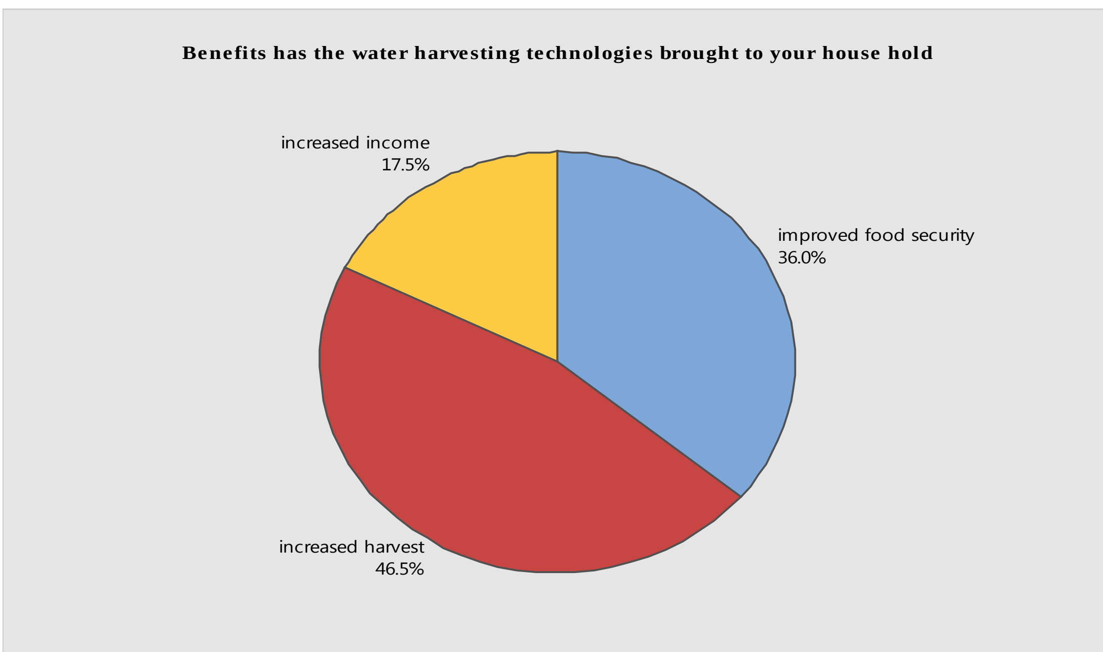

The findings in table 4.24 indicate that there is a significant variation between average acres for farming before and after initiating water harvesting technique. For instance, 51.8% of respondents used more than 10 acres of land after adopting the technique as compared to 33.3% before using the technology. Therefore, this implies that after starting the technique farmers in the project area are likely to increase the size of land in which they plant maize. The matrix is shown in table 4.23 in terms of acres for maize and beans production based on before and after the adoption of the techniques.

Table 4.25: Land utilization matrix

	Percent (%) Before	Percent (%) After
0-2 Acres	2.7	4.5
3-4 Acres	9.6	8.2
5-10 Acres	54.4	35.5
Over 10 Acres	33.3	51.8
Grand Total	100	100

Other reasons that respondents advanced for increased farm production were: increased supply of water 47%, adopting new methods of farming 25%, and use of fertilizer 23%. Also, 5% cited that reduced soil erosion because of terracing is the main reason for increased farm production. In prolonged dry seasons, RWH has been recognized as the best way to increase water supply and has extensively been adopted by the households Boateng and Gadogbe (2015) . However, some farmers in the project area did not have roof water harvesting technologies because of the following reasons: The technique was expensive, (74) 64.9%. A considerable proportion of (37) 32.5% lacked knowledge about the technique. Only (3) 2.7% did not have iron roofs. Goal (2014) states that though the capital cost of rainwater harvesting is high, neither the operation cost nor maintenance usually involves major expenditure. In addition, the writer perceives the utilization of rainwater harvesting as a beneficial way of minimizing water scarcity in developing countries.

Figure 4.7: Why not using water harvesting

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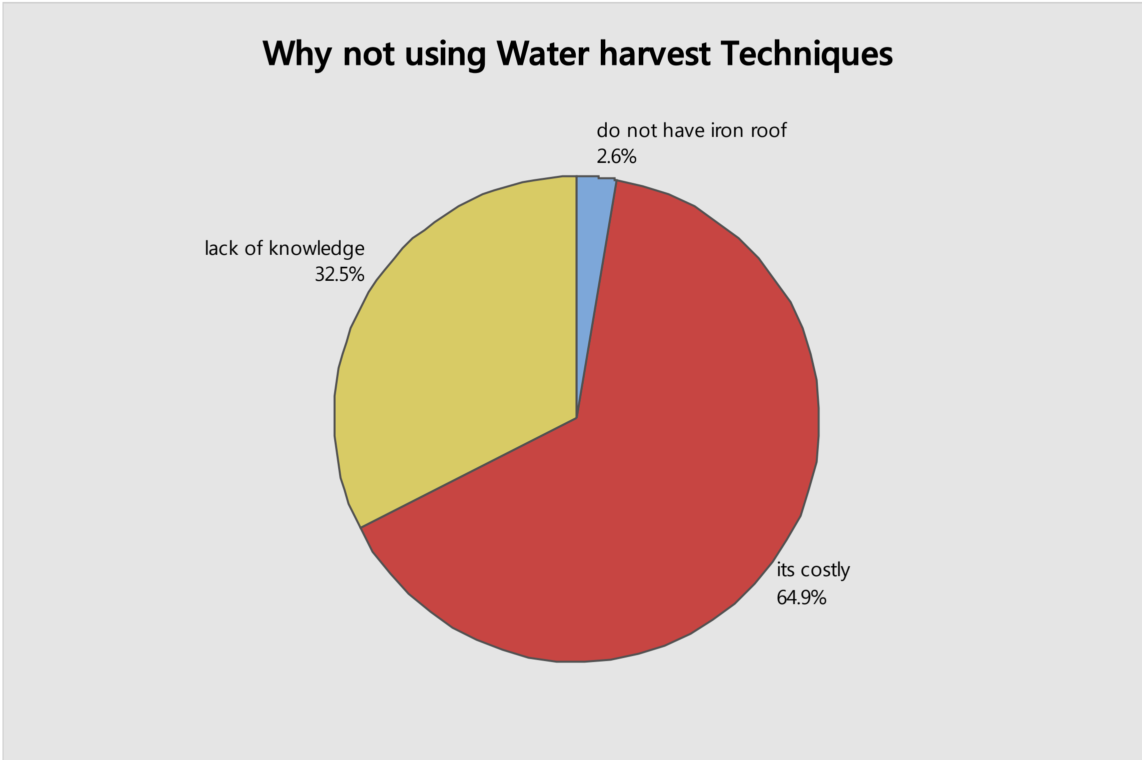

4.6 Challenges of Rainwater Harvest Techniques

4.6.1 Challenges for Water Harvesting Techniques for Domestic Use

A majority of respondents (36) 31.9% cited that the harvested water for domestic use at a time gets contaminated from the dusty roofs, followed by (30) 26.3% who reported that there are unreliable rainfall patterns. Boateng and Gadogbe (2015) found out that during the rains and before the rainwater gets to the collection point, the rainwater picks up atmospheric aerosols which affect the quality of the collected water. Further the paper denotes that water from the roof catchment may be contaminated by deposits such as birds' droppings and small animals, leaves that fall from the overlying vegetation and aerosols deposited by wind on the roof and on the guttering system.

Also, a significant proportion (27) 23.6% said that the techniques for water harvesting are expensive to install and maintain, while (21) 18% of those asked cited lack of storage facilities as a challenge. (Pacey and Cullis, 1991; Kumar *et al.*, 2008) notes that many

RWH systems demand a high initial input and therefore may be a problem to the families that are extremely poor, nomadic, or headed by women.

Qualitative information outlined the following challenges of rainwater harvesting; Topography of the land as some lands may not allow terracing, lack of enough funds, some earth dams are contaminated for domestic use and the type soil as some soils are poorly drained and not able to hold water. A male key respondent from the ministry of water noted that*:*

> *''There is a problem of poor extension services as the communities are not well trained on RWH technologies and I would recommend more sensitization, capacity building and availing the necessary technical persons to the study area.''*

Chi and Yamanda (2002) reported that farmers may feel the technology as good but they still encounter some difficulties in its use. The farmers lack capital, may lack direction from the government extension and may be uncertain of benefits hence fail to adopt.
Figure 4.8 shows the results.

Figure 4.8: Challenges for water harvesting technique for domestic use

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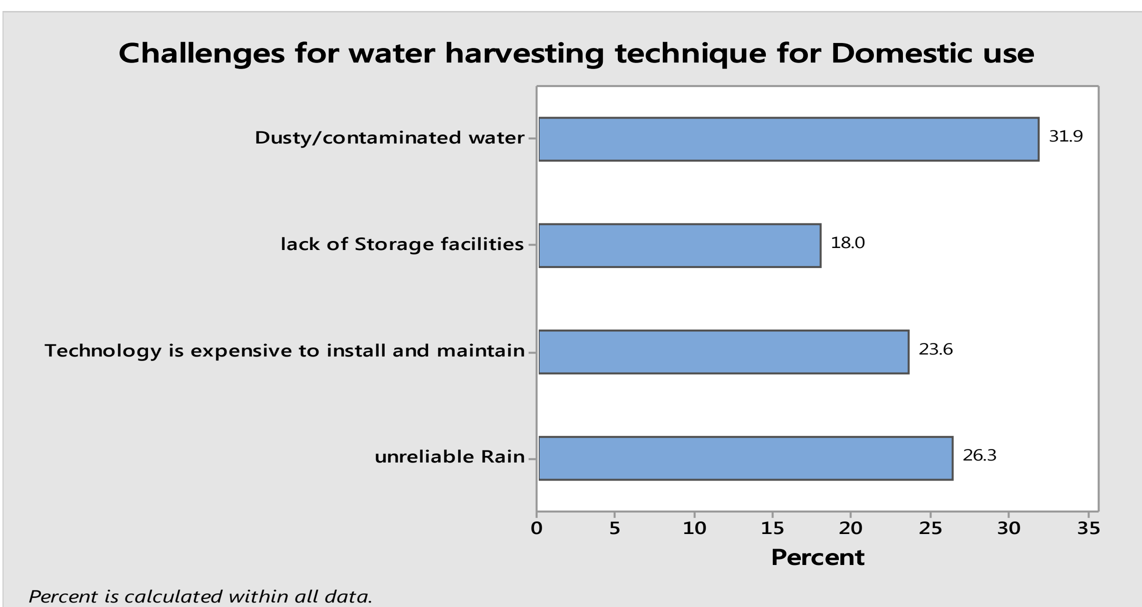

4.6.2 Challenges for Water Harvesting Techniques for Farm Use

A majority of respondents 35 (53.8%) said that the techniques were vulnerable to physical harm such as floods that cause soil erosion, collapses stone bunds, and well as destroying terracing. Also, a considerable proportion of 21 (32.3%) said that the techniques are expensive to install and required much labour. A substantial amount of labour is required in RWH practices especially in managing of runoff. Thus lack of labour affects the ability of the families to embark on rainwater harvesting (Senkondo, *et al*., (1999). Those who cited unreliable rainfall constituted 6 (13.8%) of the respondent, as presented in Table 4.26.

Table 4.26: Challenges for water harvesting technique for farm use

	No.	Percent (%)
Expensive to install and Much Labour	21	32.3
Unreliable rainfall	9	13.8
Vulnerable to physical harm	35	53.8
Grand Total	65	100

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the research concentrates on the summary of findings of the study that made the basis for discussions. From the discussions, conclusions and recommendations were made to enable address the causal factors for adoption and utilization of rainwater harvesting technologies among households in Evurore Ward, Mbeere North Sub-County, Kenya. In addition it includes the areas for further research.

5.2 Summary

The study findings showed that most of the respondents had learned about the rainwater harvesting technologies for farm use and domestic use through their neighbours, local health centres, being informed by the public health officer, educated from a local seminar attended, workshops, conferences, training, field trips, and exposure visits.

Information from the study confirmed the sources of knowledge for rainwater harvesting techniques to include; Information on Rainwater harvesting gotten from seminars, from neighbours, past experience, agricultural extension officers, learning from internets, radios, chief's baraza, agricultural shows. It was reported that some farmers too learned about rainwater harvesting from study tours where they visit other places.

The study reports the following factors that promoted the use rainwater harvesting technologies; Majority of those interviewed cited presence of iron roof in their homestead as number one factor, informal groups that enable most of the respondents to purchase tanks and too, working as team to make terraces on their farms.The study findings also show that most respondents were influenced to adopt water harvesting technologies in their farms after hearing about its long term benefit from those practicing the technology. For instance labour requirements which were affordable and desire to increase food production. The study also noted that most of the farmers from the study area had received water tanks as donations from the NGOs i.e. Compassion International, an organization that supports the needy children in the area.

The study found out that rainwater harvested for domestic use was clean for direct consumption, felt that using the technology presented no direct cost implication, and that roof water catchment requires fewer efforts to procure. Also household members spend most of their time doing other important activities, Children have more time to study and play since they do not fetch water in far way places. It was noted that those who have adopted the RWHT have an added advantage of selling water to other non-adopters or to those who harvest in little amount. Also the study reports increased farm harvests, improved food security and that water harvesting technologies have increased their income earned from the farm production. In addition, there is increased soil fertility, reduced soil erosion and water accessed throughout the year.

From the findings of the study, it was reported that rainwater harvested may at time get contaminated from the dusty roofs, others said that the technique is expensive to install and maintain and some lack of storage facilities. The technologies require high initial input and therefore may be a problem to the families that are extremely poor, nomadic, or headed by women. The study too outlined the following challenges of rainwater harvesting; Topography of the land as some lands may not allow terracing, lack of enough funds, some earth dams are contaminated for domestic use and the type soil as some soils are poorly drained and not able to hold water. He also noted the problem of poor extension services whereby the communities are not well trained on RWH technologies and recommends more sensitization, capacity building and availing the necessary technical persons to the study area.

Finally the research found out that the RWH technologies on the farm are vulnerable to physical harm such as floods that cause soil erosion, collapses stone bunds, and as well destroying terracing. Also, the techniques are expensive to install and required much labour.

5.3 Conclusion

Rainwater harvesting is essential for households both in rural and urban areas of Kenya. Some of the aspects that contribute to the adoption and utilization of rainwater harvesting technologies include Knowledge available about RWH and some of the benefits that are as the result of adoption. Water harvested is used for irrigation, for livestock, cooking, drinking, washing and too sold to non-harvesters or those that harvest less. Availability of capital and labor too contribute to the implementation of rainwater harvesting technologies for farm and for household use. In the study area, education on various methods of RWH is encouraged so as to ensure that the community embraces the new ways of farming hence increase crop production and food security.

5.4 Recommendations

1. The study recommends for more education and training of farmers on modern technologies of rainwater harvesting for farms in the study area.
2. The study also recommends for emphasis on community mobilization and sensitization about rainwater technologies and sponsorship on water tanks
3. There is a need to emphasize on more contact with Agricultural Extensionists in the study area. At least the farmers to interact with the experts at the village level
4. The research further recommends the value chain analysis of crop production to be undertaken.

5.5 Areas for Further Research

1. There is a need for further research to establish the effects of water harvesting on adoption of miraa farming in Mbeere North.

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APPENDICES

APPENDIX I: LETTER OF INTRODUCTION

UNIVERSITY OF NAIROBI

DEPARTMENT OF SOCIOLOGY & SOCIAL WORK

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December 18, 2018

TO WHOM IT MAY CONCERN

RE: SERAPHINE IGOKI NTHIGA - C50/85919/2016

Through this letter, I wish to confirm that the above named is a bonafide postgraduate student at the Department of Sociology & Social Work, University of Nairobi. She has presented her project proposal entitled, "**Casual Factors of Household Adoption & Utilization of Rainwater Harvesting Technologies in Evurore Ward, Mbeere North Sub-County.**"

Seraphine is required to collect data pertaining to the research problem from the selected organization to enable her complete her thesis which is a requirement of the Masters degree.

Kindly give her any assistance she may need.

Thank you.

Prof. C.B.K. Nzioka
Chairman, Department of Sociology & Social Work

APPENDIX II: QUESTIONNAIRE

Causal factors for household adoption and utilization of Rainwater Harvesting Technologies in Evurore ward, Mbeere North Sub-county.

I am Seraphine Igoki Nthiga a student at the University of Nairobi department of sociology and social work pursuing a Masters of Arts in Rural Sociology and Community Development. As a part of the requirement of the award of the degree, I am required to undertake research. The purpose of my coming to you is to ask you a few questions about how you harvest water in your household/farm. The questions are generally about how water harvesting is undertaken in Mbeere North. I promise to keep the information you provide confidential and it will be used for the purpose of this research only. I therefore request you to answer these few questions.

<u>Section A: Background Information</u>

County ……………………………

Sub-County …………………….

Division ………………………….

Ward …………………………….

Location ……………………………..

Sub-Location …………………………

Village ………………………………….

1. Name of respondents ……………………………
2. Gender

   Male [ ]

   Female [ ]
3. Age of respondents in years:

   18-25 [ ]

   26-32 [ ]

   33-40 [ ]

   41-47 [ ]

   48-55 [ ]

   Over 56 [ ]

4. Highest level of formal education:

No education [ ]

Primary [ ]

Secondary [ ]

Post- Secondary college [ ]

University [ ]

5. Religion:

Muslim [ ]

Christian [ ]

Traditional [ ]

6. Marital status:

Married [ ]

Single [ ]

Separated [ ]

Widow (ew) [ ]

Divorced [ ]

7. Household size:

Male [ ]

Female [ ]

Total ………………………………………………………………………………

8. Type of house:

Mud wall and grass roof [ ]

Permanent wall and iron roof [ ]

Mud wall and iron roof [ ]

Permanent wall and tile roof [ ]

Mud, cement wall and iron roof [ ]

9. Household level of income per month

0-10,000 [ ]

10001-20,000 [ ]

20001-30000 [ ]

30,001-40,000 [ ]

Above 40,000 [ ]

10. Ownership of livestock:

Cattle [ ]

Goat/sheep [ ]

Poultry [ ]

11. Land size in Acres:

0-2 [ ]

3-5 [ ]

Over 5 [ ]

12. Crops on the farm:

Maize	[ ]	Pigeon peas	[ ]	Cotton	[ ]
Beans	[ ]	Millet	[ ]	Mirra	[ ]
Green grams	[ ]	Sorghum	[ ]	Tobacco	[ ]
Cowpeas	[ ]	Horticulture	[ ]	Cow peas	[ ]

Other specify…………………………………………………………………

13. Types of water harvesting technologies practices on the farm

…………………………………………………………………………………….

13(a) Water harvesting for domestic use

Yes [ ]

No [ ]

13(b) Type of technology for domestic water harvesting.

Gutters on the roof: (i) yes (ii) No

Concrete water tank: (i) Yes (ii) No

Plastic water tank: (i) yes (ii) No

Metallic water tank: (i) Yes (ii) No

Underground water tank: (i) Yes (ii) No

Other specify…………………………………………………………………..

Water in the container at the time of interview: (i) Yes (ii) No

13(c) Water harvesting for farm use: (i) Yes (ii) No

13(d) Types of water harvesting technologies used on the farm:

Terracing (i) Yes (ii) No

Dam/water pan (i) Yes (ii) No

Pipe (i) Yes (ii) No

Mulching (i) Yes (ii) No

Stone bunds (i) Yes (ii) NO

Other specify……………………………………………………………………

13(e) Farmer uses irrigation (i) Yes (ii) No

13(f) Crops under irrigation

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

Section B: Sources of knowledge

14. For how long have you been a farmer?

0-5 [ ]

6-10 [ ]

Over 10 years [ ]

15. For how many years have you been harvesting roof water?

0-5 [ ]

6-10 [ ]

Over 10 years [ ]

16. Why did you decide to be harvesting roof water for domestic use?

I saw my neighbour [ ]

My son told me [ ]

17. What quantity of water do you harvest per season in litres?

0-5000L [ ]

5001-10000 [ ]

Over 10000L [ ]

18. For how long does the house hold use this water?

0-2 months [ ]

3-5 months [ ]

Over 5 months [ ]

19. Where did you obtain information about harvesting rain water for domestic use?

From neighbour [ ]

Public health officer [ ]

From agricultural extension officer [ ]

Seminar I attended [ ]

Chiefs Barraza [ ]

From the hardware [ ]

20. What is the cost of acquiring roof water harvesting equipment?

0-10000 [ ]

10001-20000 [ ]

Over 20000 [ ]

21 Among those who harvest roof water for domestic consumption in this area, where did they get the knowledge about roof water harvesting?

From neighbour [ ]

Public health officer [ ]

From agricultural extension officer [ ]

Seminar I attended [ ]

Chiefs Barraza [ ]

From the hardware [ ]

Read about it [ ]

22. Who installed the roof harvesting infrastructure for you?

Local fundi [ ]

Myself [ ]

Extension officer [ ]

Hardware staff [ ]

Other specify……………………………………………………………………...

23. For how long have you been using water harvesting technologies on your farm?

0-5 [ ]

6-10 [ ]

Over 10 years [ ]

24. How much did you pay to put up the water harvesting infrastructure?

……………………………………………………………………………………….

25. What is the source of labour for erecting and maintaining water harvesting technologies on your farm?

Self [ ]

Household [ ]

Wife [ ]

Paid labourers [ ]

26. Where did you obtain information on application of water harvesting technologies in your farm?

From neighbour [ ]

Public health officer [ ]

From agricultural extension officer [ ]

Seminar I attended [ ]

Chiefs Barraza [ ]

From the hardware [ ]

Read about it [ ]

27. How many water technologies do you have on your farm?

1 [ ]

2 [ ]

3 [ ]

4 [ ]

5 [ ]

28. Which ones?

Terracing [ ]

Dam/water pan [ ]

Pipe [ ]

Mulching [ ]

Stone bunds [ ]

Other specify [ ]

29. Of those technologies you have in your farm, which one is most expensive to install?

Terracing [ ]

Dam/water pan [ ]

Pipe [ ]

Mulching [ ]

Stone bunds [ ]

Other specify [ ]

30. Which is the most expensive to maintain.

Terracing [ ]

Dam/water pan [ ]

Pipe [ ]

Mulching [ ]

Stone bunds [ ]

Other specify [ ]

31. Of the technologies you use in your farm. What are the advantages of each?

Affordable [ ]

Easy to maintain [ ]

Requires less labour [ ]

32. What are the disadvantages of each of these?

Costly [ ]

Requires frequent maintenance [ ]

Requires more labour [ ]

Vulnerable to floods [ ]

Section C: Enabling Factors

33. Why did you decide to install roof water harvesting for domestic use?

I have an iron roof [ ]

Convinced by my neighbour [ ]

Information from public health about quality roof water [ ]

The source of river water is far [ ]

34. Compare roof water and river water. Which one is good for domestic use?

Roof [ ]

River [ ]

35. How did you know this?

Public health officers told us [ ]

Educated in a seminar [ ]

Information from chiefs Barraza [ ]

The local health centres encouraged us [ ]

36. Do you belong any local group?

Yes [ ]

No [ ]

37. Of what benefit has the group been to you?

Enabled buy a water tank [ ]

Exposed me to the information I did not have [ ]

38. In this village compare those who are in a group and those who are not in a group. Who are the majority with water tanks?

Those in the group [ ]

Those not in the group [ ]

39. Do you think being in a group has helped many to have roof water harvesting equipment?

Yes [ ]

No [ ]

40. Do you think if you are not a member of this group you would be having roof water harvesting equipment?

Yes [ ]

No [ ]

41. How did the group enable you to get roof water harvesting equipment?

We contribute to each member [ ]

Obtained a loan [ ]

enabled me to accumulate savings [ ]

42. Why did you decide to have water harvesting technologies on your farm?

Agricultural extension officer told us [ ]

Chief ordered [ ]

Got information from seminar I saw my neighbour [ ]

I visited a local demonstrations farm [ ]

43. What is the reason that influenced your decision to adopt water harvesting technologies in your farm?

Initial cost of the technology [ ]

Labour requirements [ ]

Long term benefits [ ]

The severity of soil erosion [ ]

44. What is the second main reason that influenced?

Desire to undertake irrigation [ ]

Desire to increase food production [ ]

To increase my income like my neighbour. [ ]

45. Quantity of the farm produces before and after adoption.

Before in Kgs	**after in Kgs**
Maize ………………..	Maize……………….
Beans………………..	Beans………………….
Green grams…………	Green grams………………
Cowpeas……………..	Cowpeas………………..
Miraa…………….	Miraa………………..
Horticulture……………..	Horticulture…………

Other specify…………………………………………………………………………….

46. Income from farm produces before and after adoption.

Before in Ksh.	**After in Ksh.**
Maize ………………..	Maize……………….
Beans………………..	Beans………………….
Green grams…………	Green grams………………
Cowpeas……………..	Cowpeas………………..
Miraa…………….	Miraa………………..
Horticulture……………..	Horticulture…………

Other specify……………………………………………………………………………

Section D: Benefits of rainwater harvesting to the household

47. What are the benefits of roof catchment water for the household?

Less energy used to procure [ ]

Cleaner [ ]

No need to treat [ ]

No direct cost implication [ ]

48. What benefit is roof catchment water to the members of the house hold?

Children have more time to study and play [ ]

My wife does not get tired [ ]

Most time to do other things [ ]

Not cost for water treatment [ ]

Saves fuel for boiling [ ]

49. What benefits has the water harvesting technologies brought to your household?

Increased harvest [ ]

Improved food security [ ]

Increased income [ ]

50. What was your household income per season before you adopted?

0-5000 [ ]

5001-10000 [ ]

10001-20000 [ ]

Over 20000 [ ]

51. What is your income today per season?

0-5000 [ ]

5001-10000 [ ]

10001-20000 [ ]

Over 20000 [ ]

52. What was your maize production per acre before you adopted rainwater harvesting technologies?

0-2 [ ]

3-4 [ ]

5-10 [ ]

Over 10 bags [ ]

53. What is your maize production per acre today?

0-2 [ ]

3-4 [ ]

5-10 [ ]

Over 10 bags [ ]

54. What was your beans production per acre before you adopted?

0-2 [ ]

3-4 [ ]

5-10 [ ]

Over 10 bags [ ]

55. What is your beans production per acre today?

0-2 [ ]

3-4 [ ]

5-10 [ ]

Over 10 bags [ ]

56. What do you think is the main reason for increased farm production?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

57. Why do you think some farmers like you in this area do not have roof water harvesting technologies?

Its costly [ ]

Do not have iron roof [ ]

Lack of knowledge [ ]

Others specify [ ]

Section E: Challenges

58. Mention at least three challenges you face with water harvesting technologies for domestic use.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

59. Mention at least three challenges you face with water harvesting technologies for farm use.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

Section F: Recommendations

60. What recommendations would propose to enhance roof water harvesting in this area?

…………………………………………………………………………………………

…………………………………………………………………………………………

61. What recommendations do you propose to enhance adoption of farm technologies?

…………………………………………………………………………………………

…………………………………………………………………………………………

APPENDIX III: FOCUS GROUP DISCUSSION

Causal factors for household adoption and utilization of Rainwater Harvesting Technologies in Evurore ward, Mbeere North Sub-county.

I am Seraphine Igoki Nthiga a student at the University of Nairobi department of sociology and social work pursuing a Masters of Arts in Rural Sociology and Community Development. As a part of the requirement of the award of the degree, I am required to undertake research. The purpose of my coming to you is to ask you a few questions about how you harvest water in your household/farm. The questions are generally about how water harvesting is undertaken in Mbeere North. I promise to keep the information you provide confidential and it will be used for the purpose of this research only. I, therefore, request you to answer these few questions.

1. Comment on the main water harvesting technologies in this area
2. Explain the factors that hinder most farmers from adopting RWHT
3. Challenges of water harvesting technologies in this area
4. Ways to help all farmers adopt
5. Sources of knowledge for Rainwater harvesting technologies
6. Benefits to household utilization of water harvesting technologies
7. Recommendations

APPENDIX IV: KEY INFORMANT INTERVIEWS

Causal factors for household adoption and utilization of Rainwater Harvesting Technologies in Evurore ward, Mbeere North Sub-county.

I am Seraphine Igoki Nthiga a student at the University of Nairobi department of sociology and social work pursuing a Masters of Arts in Rural Sociology and Community Development. As a part of the requirement of the award of the degree, I am required to undertake research. The purpose of my coming to you is to ask you a few questions about how you harvest water in your household/farm. The questions are generally about how water harvesting is undertaken in Mbeere North. I promise to keep the information you provide confidential and it will be used for the purpose of this research only. I, therefore, request you to answer these few questions.

1. What are the main water harvesting technologies in this area?
2. What factors hinder most farmers from adopting them?
3. What are the challenges of water harvesting technologies in this area?
4. What can be done to enable all farmers to adopt?
5. What are the sources of knowledge for Rainwater harvesting technologies?
6. What are the benefits to household utilizing water harvesting?
7. What recommendations do you have?