ASSESSING FACTORS AFFECTING ADOPTION OF ROOF WATER HARVESTING FOR DOMESTIC USE:
A case study of Kalawani & Kathiani Division, Machakos District, Kenya

BY:

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Project report submitted in Partial Fulfillment of the Requirements of the Award of Master of Arts Degree in Development Studies, Nairobi University.

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DECLARATION

This project is my original work and has not been submitted for the award of any degree in any university.

Joan Kariuki

Date

.....Kariuki.....

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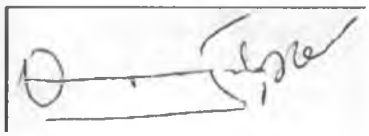
This project has been submitted for examination with our approval as the university supervisors.

Dr. Joseph Onjala

Date



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.....23rd NOV 2011.....

Dr. Kaendi Munguti

Date

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.....24 NOV 2011.....

DEDICATION

To mum Monicah for her inspiration and support, to my sister Daisy and Shiro for moral support and to my husband Anthony for your encouragement.

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In the course of conducting this study I received abundant support and invaluable help from many people time will not allow me to mention them all; hence I take this opportunity to thank them all for their contribution.

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List of Abbreviation

DRWH	Domestic Rain Water Harvesting
RWH	Rain water Harvesting
DFID	Department for International Development
UNCED	United Nations Conference on Environment and Development
UNDP	Untied Nation Development Programme
UNIFEM	United Nations Development Fund for Women
MDG	Millennium Development Goal
PRSP	Poverty Reduction Strategy Paper
CBS	Central Bureau of Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
DTU	Development Technology Unit
UN	United Nations
IUCN	International Union for the Conservation of Nature
WHO	World Health Organization
WRUA's	Water Resource User Association
TDS	Total Dissolved Solids

Abstract

This study sought to examine factors that influence the adoption of Rainwater Harvesting (RWH) Technology by looking at socioeconomic economic factors that influence adoption of RWH. Various socioeconomic characteristics were considered. They included education of household head, gender, family size, income, roofing material, technology access to information age, group networking and sources of income.

Data was collected using a combination of data collection methods including; survey interviews, key informant interviews and direct observation.

Therefore, the main objective of the study was to examine factors that influence the adoption of RWH in Kathiani and Kalawani division of Machakos district. Data collected was cleaned, coded and keyed in preparation for analysis, was analyzed by use of SPSS and summarized according to the study objectives using descriptive and inferential statistics such as frequency tables, cross tabulation, charts and bar graphs to come up with conclusions and recommendations.

The findings revealed that lack of finances played key role in hindering adoption of RWH, in addition inaccessibility to information and poor technology too contributed to lack of adoption of RWH for domestic use. Roofing material was observed not to be a problem in the area but storage facilities and guttering was observed to hinder adoption of RWH.

The study therefore concluded that adoption of RWH in Kathiani and Kalawani divisions has been hindered due to the lack of resources necessary for installing RWH structures. In addition inadequate access to information particularly by women and lack of knowledge on maintaining of RWH technologies has contributed to lack of adoption of RWH.

The study therefore recommends that deliberate efforts be put in place to avail resources for subsidizing RWH in the area. The study also recommends capacity building of community with regards to RWH technology.

CHAPTER ONE: INTRODUCTION

1.1 Background information

Water is essential for life, a basic requirement for the proper functioning of the global ecosystem. Lack of access to safe water has severe consequences for human's health and livelihood. Water is necessary for human to lead lives free of destitution, deprivation, and scarcity. The development community has long understood the necessity of water for human and economic development. The United Nations Development Program uses data on access to water as one of the two variables in the 'Human Poverty Index' (HPI-1) that indicates 'deprivations in a decent standard of living[1]' (UNDP, 2003)

The world population is expected to reach 8 billion by the year 2020 (UNFPA, 1997). Food and water will be in high demand with the increasing population. The ongoing debate about the world's ability to feed the rising population has paid little or no attention to how the population growth will impact on household water access, particularly in developing countries.

According to Vasudevan (2001), water is a fundamental basic need for sustaining human economic activities. However, despite the construction of numerous new water supply systems in rural Africa in the last decade, population growth has resulted in only a small projected increase in the fraction of between 32 per cent and 36 per cent of households having "access to adequate quantities of safe water" (WHO, 1996; UNICEF, 2000).

The growing demands for water against the limited temporal natural endowment and its increasing scarcity could result in conflicts and catastrophes (Kenya, 2002). It is estimated that one third of the world's population do not have access to clean drinking water. This translates to about a billion people globally who lack access to clean drinking water and over 2.4-billion who lack access to proper sanitary facilities (UNDP, 2003). This results in a faster

[1] The HPI-1, the poverty index for developing countries, measures deprivations in longevity, in knowledge, and in a decent standard of living. A decent standard of living is measured by two variables: the percentage of people not having sustainable access to an improved water source and the percentage of children below the age of five who are underweight (UNDP 2003)

increase in the number of people suffering from water-borne diseases than any other ailment. Some two million children die every year of diarrhoea (Centre for diseases control, 2003). Incidences of diarrhea can be reduced by 26 per cent if basic water, hygiene, and sanitation are observed (World Water Day, 2001). Children in particular suffer poor health as a result of direct injury through hauling heavy water carriers commonly 15-20 litres over long distance and use of insufficient amount of water to maintain adequate standard of hygiene (Carter and Howsam, 1999). More than 800 million people, 15 per cent of the world's population are malnourished, partly due to insufficient water for crops (DFID, 2001). A large proportion of this population is located in the developing world where there are difficulties in accessing improved water for domestic use. Furthermore, official statistics is based on understanding of the words "access", "adequate" and "safe" that seem inappropriate to rural Africa. "Adequate" is taken to mean over 20 liters per person per day (lcd) and "access" is taken to mean a water source within one kilometer from the home (DTU, 2000). In Kenya, like elsewhere in the world, access to reliable, safe, affordable quality water and sanitation is a dream for many, yet it is one of the keys that unlock the yokes of poverty, facilitate economic growth, promote good public health and improve living standards.

Efforts have been made to avail water and sanitation services to hundreds of millions of the world's poorest people. The most outstanding of these efforts was the launch in 1981 of the International Drinking Water Supply and Sanitation Decade, which resulted from the Mar del Plata Action Plan adopted by the United Nations Water Conference in 1977. The commonly agreed premise was that "all people, whatever their stage of development, social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs" (UNCED,1992). Following this, in 1992 the Earth Summit in Rio de Janeiro set goals for sustainable development, including guaranteeing every individual access to clean water and sanitation (UNCED, 1992). Significant progress has been made since then. However, despite these efforts, millions of people throughout the world still do not have access to this basic necessity. After decades of work by governments and organizations to bring potable water to the poorer people of the world, the situation is still dire. The reasons are many and varied but generally speaking; the less fortunate of the world cannot afford the capital intensive and technically complex traditional water supply

systems, which are widely promoted by governments and development agencies throughout the world.

Kenya is a water-scarce country.[2] This is due to limited national endowment and the needs of a growing population. This problem has been compounded by water resources degradation and low investments in infrastructure development, maintenance and operations. The Kenya National Development Plan (1994-96) aimed at ensuring availability of potable water within four kilometers of every household by the year 2000. To date, this has not been achieved.

In Kenya, statistics on water shows that in 1972 only 9% of the rural population had supply of 'safe' water schemes, the number rose to 20% by 1989 and by the year 2000, it rose to 42% (Huggins, 2005). By 2002, at least 46 per cent of the rural population had access to improved water in Kenya (UN 2002, World Bank, 2006).[3] The water sector has the potential to substantially improve the lives of Kenyans by ensuring access to clean water and acceptable sanitation services. Besides this, water is central to the achievement of Kenya's socio-economic development goals. Lack of access to water and sanitation, has aggravated the high poverty levels in Kenya. This has been confirmed The Kenya Poverty Reduction Strategy Paper (PRSP) of 2001 to 2004 which assessed 64 districts. Out of these, 78 per cent reduction of poverty was linked to access to water, the document further stated that, 'access to water for human consumption, agriculture and livestock use is a major problem in rural areas' (Kenya, 2004).

Therefore, for Kenya to improve its economic performance and get to poverty reduction, it needs to invest more on water infrastructure and improve on management of water resources. The key sectors of the Kenyan economy are directly dependant on reliable and adequate supply of good quality water they include manufacturing, agriculture, energy livestock, environment and tourism. Immediate attention need to be given to sustainable supply of domestic water, particularly in rural areas, if the global target of halving the

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[2] Water Scarcity: This is the condition that exists when the demographically induced demand for water exceeds the prevailing level of local supply, meaning that supply-sided augmentation becomes necessary (Turton & Meissner, 2000).

[3] Improved water here means any of the following types of water supply for drinking: piped water, a public tap, a borehole with a pump, a protected well, a protected spring or rainwater (UN2002)

number of people without access to water and sanitation is to be achieved by 2015 as stated in millennium declaration UNDP (2000). Quite a number of countries were already facing serious water shortage before the declaration, (Handlye et al 1995, Spulbers and Sabbagi 19980). To address these challenges, adoption of rainwater harvesting (RWH) has been proposed as away to augment existing water supply.

1.2 Concept of Rainwater Harvesting

The term rainwater harvesting (RWH) is used in different ways and, thus, no universal classification has been adopted (Ngigi, 2003). According to Critchley and Siegert (1991), water harvesting in its broadest sense is defined as the "collection of runoff for its productive use". Runoff may be harvested from roofs and ground surfaces, as well as from intermittent or ephemeral water courses. The captured rainwater is used as a principal or supplementary source of water. Productive uses include the provision of domestic and livestock water; concentration of runoff for crops, fodder and tree production and, less frequently, water supply for fish and duck ponds. Gould and Nissen-Peterson (1999) cites examples of systems that provide water for domestic, commercial, institutional and industrial purpose.

A lot of studies have been carried out on rainwater harvesting for agricultural use in East Africa and Kenya in particular (Ngigi, 2003; Rockström, J. (2001); Hatibu (1999); Theib et al 1999). Moreover many studies have looked at factors that influence adoption of RWH for intensive agriculture; however there is very limited literature on rainwater harvesting for domestic use. RWH for domestic use is often considered to be a traditional method of water collection and storage. The practice of RWH for domestic use can be traced back many centuries, especially in countries like Sri Lanka and India where DRWH is mentioned in ancient inscriptions as far back as the 5th century BC (DFID, 2003). However, types and methods of DRWH have changed over time and many different systems are now available all over the world. After a relatively long period of being locked out, DRWH is currently making an impact in many countries (especially in the developing world) as an alternative household water supply option. A number of reasons can be attributed to this resurgence, the more important of which are as follows:

- Decrease in the quantity, quality of groundwater, surface water and failure of many piped water schemes due to poor operation and maintenance of infrastructure.

- Improvement in roofing material from thatched to more impervious materials like tile, corrugated iron sheets and asbestos.

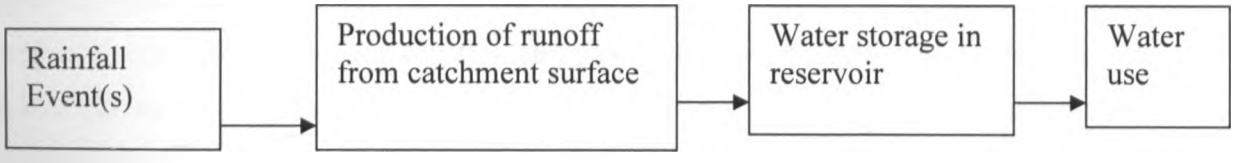
- Increased availability of low cost DRWH technology.

- Shift from more centralized to decentralized management and development of water resources through increase in importance of community ownership of development infrastructure.

- Increase in competition between different water sectors and the global trend towards rural to urban migration

A rainwater harvesting system consists of three basic elements: a collection area, a conveyance system, and storage facilities. Houses or buildings' roofs serve as the collection area in most cases. The efficiency and quality of water is influence by the effective roof area and the material used in constructing the roof. A conveyance system usually consists of gutters or pipes that deliver rainwater falling on the rooftop to cisterns or other storage vessels.

Figure 1: Flowchart illustrating fundamental rainwater harvesting processes



Source: Gould and Nissen- Peterson,1999

Both drain pipes and roof surfaces should be constructed of chemically inert materials such as wood, plastic, aluminum, or fiberglass, in order to avoid adverse effects on water quality (UNEP, 1997). The water is stored in a storage tank or cistern, which should also be constructed of an inert material. Reinforced concrete, fibre glass, or stainless steel is suitable materials. Storage tanks may be constructed as part of the building, or may be built as a separate unit located some distance away from the building. All rainwater harvesting systems share common components that include: Catchment surface from where runoff is collected like roof surfaces, systems for transporting water from catchment surface to storage reservoir, reservoir where water is stored until needed and device for extracting water from reservoir (Gould and Nissen- Peterson,1999).

Developed countries too are returning to the technique. This is attributed to housing growth, changing lifestyles, and climate change that have put pressure on already stretched water resources (Meera and Ahammed, 2006, Sarah 2006). According to Konig (2001) RWH can help in supplementing the mains water supply for non-potable uses (toilet flushing, washing machines, garden irrigation, general cleaning); reduce loads on sewers by acting as a source control measure and reduce pollution to surface waters by reducing urban runoff.

Therefore, in an area where access to clean water is a problem, questions arise on why the community has not adopted RWH to supply domestic water needs. This study therefore looked at factors influencing adoption of RWH

1.3 Statement of the problem

Access to clean water has remained an enormous challenge, particularly in rural areas of Kenya. In the past, the government has attempted to come up with a range of strategies to address this problem by setting targets such as availability of potable water at a reasonable distance to all households by the year 2000 (Kenya,1974). In the same spirit, the government has in the past attempted to address the challenge of access to clean water through large scale water schemes such as dam construction and pipe water supply. However, these approaches proved challenging due to high costs as a result of unique and rugged terrain and dispersed settlement patterns in rural areas. Therefore, alternative methods of improving access to clean water by rural households are continuously being sought.

Water is one of the scarce natural resources in Kathiani and Kalawani division of Machakos district, on examining literature on the sources of water in Machakos District, it emerged that the main sources of water in the district are rivers, wells and boreholes beside piped water supply within the municipality (Kenya, 2008). According to the Machakos District Development Plan, the district has one permanent river, 175 shallow wells, 34 protected springs, 75 unprotected springs, 75 water pans, 77 bore holes and the average walking distance to the nearest water point is 3km. These sources have been observed to have limitations ranging from long distance, insecurity, time wasted and poor water quality. Though water is essential for life, health and human dignity (WWAP, 2006), it remains a

major challenge particularly in Kathiani and Kalawani division. The people in the area depend on rainfall which is erratic and very little, there is only one permanent river hence the people depend on seasonal rivers which dry up during prolonged dry season. The women have to travel long distances to get water from bigger rivers where water can still be found. The people of the area struggle to obtain water for domestic use and this leaves them with less time to engage in productive activities for self substance and for food security. However, studies have shown potential benefits of domestic Rain water Harvesting (RWH). The use of harvested rainwater for domestic use is still limited in Kathiani and Kalawani division, as such; questions arose as to what factors have influenced adoption of RWH.

Rain water harvesting is an option for improving access to clean water. RWH in its broadest sense is defined as the "collection of runoff for its productive use". Runoff may be harvested from roofs and ground surfaces, as well as from intermittent or ephemeral watercourses (Ngigi, 2003). RWH is an option that has been adopted in many areas of the world where conventional water supply systems have failed to meet people's needs. It is a technique that has been used for long time. Kenya has rainwater-harvesting capacity of 12,300 cubic meters against its current annual renewable water availability of just over 600 cubic meters (Africa Water & Sanitation, 2007).

Adoption of RWH technology indicates potential benefits such as time saving, girls' education not interrupted (Thomas, 2001). It is therefore through understanding of the factors that influence adoption that further insights can be developed regarding strategies to promote RWH. To address this, it emerged that there is need to look into socio-economic factors and gender aspect of the community and how this influences the adoption of RWH by the community. Kathiani and Kalawani division were selected for this study due to a number of reasons:

(i) Several training activities have been conducted on RWH,

(ii) It is located in semi arid regions in Kenya, and three,

(iii) Its accessibility

(iv) Its variable water sources available as indicated in the study by Kimuyu (1998)

(v) Its challenge of total dissolved solids in borehole water. The divisions also experiences perennial shortage of water due to frequent droughts (Kenya, 2002). This research, therefore,

sought to fill research gap on the extent to which socio-economic factors influence the adoption of Rain Water Harvesting. In addition, in an attempt to investigate the extent to which socio-economic status and gender influences adoption of RWH, this study sought to provide answers to the following questions.

1.4 Research Questions

- What are the sources of water in the study area?
- What are the socio-economic factors that influence the adoption of RWH for domestic use?
- Do gender roles influence the adoption of Domestic Rainwater, Water Harvesting systems at the household level?

The overall objective was to examine the factors that impact on adoption of Rain Water Harvesting for domestic use in Kathiani and Kalawani division.

1.5 Specific objectives

1. To examine sources of water in the study area
2. To find out socio- economic factors that influence the adoption and sustained use of RWH at household level, and
3. To examine the influence of traditional gender roles on the adoption of RWH technologies

1.6 Scope of the study

Conventionally, rainwater harvesting can be carried out on rock , land and roof surface. While acknowledging the important role that these types of RWH play, this study has focused on RWH using roof surface in Kathiani and Kalawani division of Machakos District. This is because investigating all types of RWH technology will need a lot of financial outlay and time which are not at the researcher's disposal.

1.7 Justification

Several studies have been carried out on RWH and challenges associated with it. Despite the increasing interest in the use of RWH, few studies have been carried out that include socio-economic factors and how they impact on adoption. This particular study focuses on how socio-economic factors have direct influence on adoption of RWH. The research findings

from this study will be useful to decision-makers and development organizations when identifying key factors to consider when promoting RWH in any given community. It is hoped that the findings of this study will contribute to the efforts of the Kenya government in improving access to clean water in rural areas. In addition, the study findings will contribute to the scholarly debate on the use of conventional water supply through piping versus RWH. Finally, earlier studies have focused on technology, catchment area versus storage facility or RWH for agricultural use. This study, however, seeks to specifically investigate socio-economic factors that influence the adoption of RWH for domestic use.

The information generated can be used to inform government and institutions responsible for water supply in rural areas. The study further aimed at contributing to the debate on RWH as an important source to augment water supply for domestic need.

1.8 Structure of the report

The first chapter of this report gives the background to the study, defines the research problem and spells out the objectives of the study. A review of relevant literature on adoption, empirical literature on factors that influence adoption of technologies and link to adoption of RWH, and historical background of RWH and policy constraint to adoption of RWH is presented in chapter two. In chapter three, conceptual framework was covered. Chapter four covered methodology including the study area, sources of data and sampling technique are discussed. Chapter five presents' findings and discussion of the results, Chapter six gives summary of findings from the study and the conclusions that were made and subsequently the recommendations were proposed.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The literature reviewed in this study covers the following topics: history of rainwater harvesting, basic concepts and theoretical foundation of adoption, technology adoption process, empirical studies of factors affecting adoption of technologies, policy constraint to RWH and gaps in other studies.

2.1 History of Rainwater Harvesting

The exact origin of RWH is not known. However, Gould and Nissen-Peterson (1999) give details of RWH systems that are associated with Middle East civilization. Rainwater harvesting is an old technique that may date back to as long ago as 4500 B.C. by people of Ur and other places in the Middle East, (Frasier, 1980). A water-harvesting system was used for runoff farming in Israel's Negev Desert 4000 years ago (Evanary *et.al.* 1961). American Indians used similar systems 700 to 900 years ago in the southwestern United States. In Asia, the practice can be traced back to almost 2000 years (Gould, 2002); while according to Hofkes (1988), Romans cities were planned to suit rainwater harvesting for drinking. This brings the question as to why the technology of roof water harvesting has not been widely adopted, considering that it has been in existence for such a long time?.

Along the coast of Africa, rainwater collection systems known locally as Djabias have been constructed for several centuries and are still used today (Bambrah *et.al.*, 1994). In the early 20th Century rainwater harvesting systems were often built at missions, churches and schools, especially in localities suffering periodic water shortages (Bambrah *et. al.*, 1994). In Kenya, there are many examples of systems built in the early 20th Century. They include rock catchments built in Kitui in the 1950s. One of the largest and most successful roof catchment systems in Kenya is that of Machakos dioceses. It was coordinated by Catholic dioceses development office. The project covered the whole district. It supported household groups to start up revolving funds for financing development of concrete tanks. Despite such initiatives, very few households adopted RWH for domestic water supply raising the question of what could be the reason.

Therefore, it is important to note that as the above literature reveals RWH is not a knew technology but has been in existence for a long time, it also reveals that RWH has been practiced in many places, as a result this study sort of examines factors that have limited wide adoption of RWH technology considering that access to water is still a challenge to many.

It is important to note that in the past, most efforts in trying to improve access to safe water had basic need approach as a guide. This approach was based on assumption that majority of those without access to water are poor and not able to pay for improved services (Kimuyu, 1998). As a result, a number of water services were developed with subsidies from the government. However, these services were unreliable and were later abandoned as they became dysfunctional. Many reasons have been cited as to why RWH is attractive (Fok, 1994; Ladu, 1994; Wanyonyi, 1999; Thomas, 2000). For instance RWH is a traditional method and people are familiar with the technology. In addition, relatively limited technical knowledge is required and it is easily understood. RWH systems are easy to construct, utilizing locally available materials, and can be undertaken by a local population The system is convenient, offering easy access to water at home and also the system produces relatively good water. The system can be implemented at household level, offering households independence from the control of outside bodies.

The above literature shows the benefit of RWH, it also shows that it is easy to adopt with limited technical requirement. Furthermore RWH is perceived to be easy and should be implemented at household level. This study sought to establish if this is true in the case of Kathiani and Kalawani division and document the observed result.

2.2 Basic concepts and theoretical foundation of adoption

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas (Ray, 2001). An innovation diffuses within a social system through its adoption by individuals and groups. The spread of innovations across social groups over time is referred to as the diffusion of innovations (Stoneman, 2002).

Diffusion is defined by Rogers (1995) as "the process by which an innovation is communicated through certain channels over time among members of a social system." and has successfully been applied in rural contexts since the 1940s (Fliegel 1993) with the focus being on the uptake of agricultural innovations such as herbicides, hybrid seed and fertilizers (Rogers, 1995). Fisher, Norvell, Sonka and Nelson (2000) explain that diffusion differs from adoption in that it is the process by which new technologies are spread among users whereas adoption is said to be an individual, internal decision.

Rogers (1983 3: 21) defines adoption as "a decision to make a full use of an innovation". In this case study it means actual use of RWH technology for domestic use. Davis (1989) also adds attitude towards use and intention to use as the factors influencing the adoption. (Further definition by) Feder, *et.al.* (1985) further defines adoption as an outcome of a decision to accept a given innovation. While quoting Roger's earlier work of 1962 define adoption as "a mental process an individual passes from first hearing about an innovation to final utilization". Successful adoption depends on favorable convergence of technical, economic, institutional and policy factors (Feder et al., 1985; Rogers 2003). There are different types of models that have been used to explain adoption decisions of new technologies. However, no single model can embrace and explain all aspects of adoption and the traditional attitude of smallholder farmers (households) towards technologies (Thangata and Alavalapati, 2003). Rogers (1995) developed the adoption and diffusion of innovations theory, which has been widely used to identify factors that influence decisions to adopt or reject an innovation. He defines an innovation as a "new idea, practice or object that is perceived as new by an individual or other unit of adoption" and said that the perceived newness of the idea for the individual is what determines their reaction to it. According to Thangata and Alavalapati (2003) adoption is determined by several factors including socio-economic, environmental, and mental processes that are governed by a set of intervening variables such as individual needs, knowledge about the technology and individual perceptions about methods used to achieve these needs.

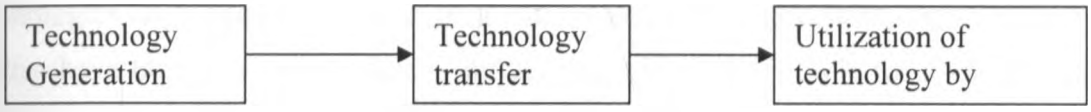
2.2.1 Technology Adoption process.

The decision of whether to adopt a new technology requires the adopter to go through a thorough decision-making process. Astebro (2004) lists three main decisions that must be

made prior to the actual adoption of the new technology. They include: whether to adopt the new technology, this includes determining the new technologies potential influence on the firm's profit margin both in the short-term and over the long-term, the depth of adoption, which is how much the firm wants to exploit the new technology and final decision is the speed at which old technology is replaced by the new technology (Astebro 2004). The study by Astebro assumes that individual adopter such as households or farmers will react in the same way as corporate of firms.

Similarly, Rogers (1962) argues that diffusion of innovation goes through five- step process, the five stages are categorized as; awareness, interest, trial and adoption. An individual may reject an innovation at any time during and after adoption. Rogers (1995) provides a linear model of the diffusion process within agriculture.

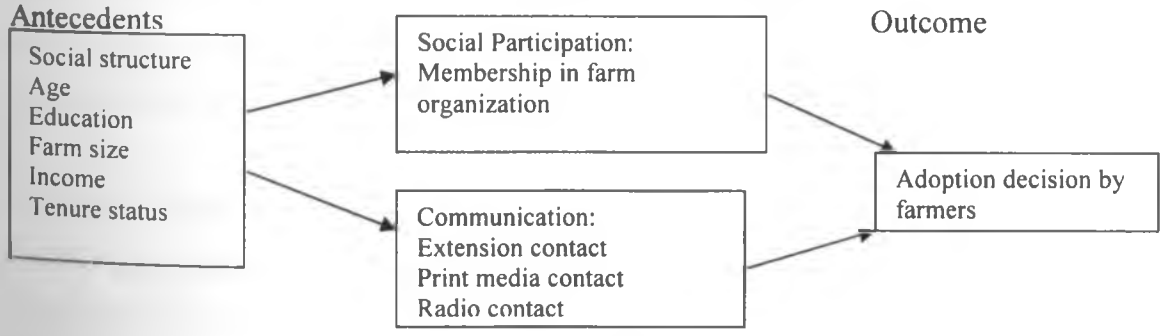
Figure 2: Diffusion as linear model



Source: Rogers 1995

However, Fliegel (1993), with support from Feder and Umali (1993), proposes a more widely accepted, non-linear approach to the adoption of agricultural innovations. He argues that the linear approach tends to restrict diffusion to a rational, planned process that relies on institutions such as government departments, rather than viewing the farmer as a passive individual who responds to random forces related to social participation and communication.

Figure 3: A non linear approach to the adoption of agricultural innovations



Source: Fliegel 1993

In the past, in order to identify factors likely to influence adoption behavior, theoretical frameworks have been developed, Adesina and Zinnah (1993) defined three paradigms, these are; the innovation diffusion, resource constraint and adopter perception paradigm. In the economic constraint paradigm, the stress is on the factors that influence the profitability or utility of innovations, while the innovation-diffusion-adoption paradigm emphasizes access to information and how this relates to understanding the process of technology adoption. The adopter perception paradigm sequentially put emphasis on the important role of attitudes and perception in the decision-making process when it comes to smallholder farmers.

Literature review on agricultural adoption found that variables such as age, experience, gender, and education of decision- maker, labor, farm size, access to information, access to credit, wealth, risk aversion, land tenure etc are important for making decision on adoption in developing countries (Feder and Umali 1993, Feeder, Just and Ziberman, 1985). This study is based on a case where a lot of studies on factors influencing adoption of agricultural technologies have been carried out including conservation agriculture, however very little studies have been covered on factors influencing adoption of RWH for domestic use, this study therefore seeks to contribute to the study on adoption of RWH for domestic use in Kathiani and Kalawani division where access to water is a problem.

2.2.2 Empirical Studies on Factors Affecting Adoption of Technologies

A number of empirical studies have been conducted by different people and institutions on the adoption and diffusion of technology innovations. But, the studies are mainly conducted around major agricultural practices such as conservation tillage agroforestry and soil conservation and due to this fact the studies conducted on the area of rainwater harvesting technologies are very limited. As a result of this, the review mainly included such studies conducted in different contexts.

Looking at literature on adoption of agroforestry technologies, there is association between wealth and planting of improved fallows (Phiri et al., (2004); Kiel *et al.*, (2005). Furthermore, by examining the literature on adoption (Griliches, 1957; Lionberger, 1960; Rogers, 1983; Alston, Norton and Pardley, 1995), who describes the process of adoption as taking on a logistic nature. It increases with time (as the stock of knowledge increases),

reaches a maximum level, and later decreases as the technology depreciates or becomes obsolete. Though agroforestry is different from the current study, the review of literature sort to establish if RWH adopters share the same challenges as adopters of various agricultural technologies; will the same association apply in adoption of RWH technologies in Kathiani and Kalawani divisions?

In addition, farm size is a proxy for wealth, and perhaps a proxy for social status within the community. The same study examined factors that influence adoption of improved maize variety. The result on farm size was therefore not surprising, bigger farms imply more resources and hence better ability to buy seed. In exploring the determinants of adoption on improved natural resources management practices among smallholder farmers at household level, for instance, Marenya and Barrett (2007) found out that resource constraints limited many farmers' capacity to adopt the practices and that such capacity is linked to farm size, livestock value, off-farm income, family labor supply, and education.

The above literature shows that in the case of agriculture resource constraint largely influenced the adoption of improved crop varieties. The available resources may influence choice made between adoption and other livelihood needs, in area like Kathiani and Kalawani where there is prevalence of poverty and erratic rainfall it is important to study the influence resources (wealth) have on the adoption of RWH for domestic use in this way, this study will be building up on the role of resources in adoption of RWH.

In a study conducted by Kabwe on factors affecting adoption of agro-forestry, age is one of the factors that have been extensively considered as a socio-economic factor influencing adoption of agroforestry (Ajayi *et al.*, 2003). This will serve in providing background information to the research being carried on influence of age on adoption of RWH for the case of Kathiani and Kalawani division.

Other considered factors include membership in farmers' clubs and cooperative groups, availability of labor supply, the degree of innovativeness of individual farmers (Ajayi *et al.*, 2006) and expensive fertilizer prices (Gladwin *et al.*, 2002). In the case of this study, group

membership will be examined to determine if they influence the adoption of RWH for domestic use.

A study by Salasya (1998) reported that number of years in school has a positive influence on the adoption of improved maize variety; education thus provides an opportunity for individuals to acquire and process knowledge about new varieties. His study further established that distance to the market and number of cattle owned (wealth) were significantly different for adopters and non adopters. Moreover, studies by De Groote *et al.*, (2005) have also found that schooling had a positive impact on the adoption of fertilizer.

Therefore, as much as literature shows that education has positive impact on adoption of agricultural technologies and can be very desirable in adoption of agricultural technology, there is need to critically analyze how effective education has been in promoting adoption of RWH in the study area.

Studies by Nkonya, Schroeder and Norman (1997) shows that, depending on the technology being investigated, various parameters may be employed to measure adoption, furthermore, measurements also depend on whether they are qualitative or quantitative. For instance in the study investigating the adoption of improved seed and fertilizer in Tanzania, it estimated the intensity of adoption by examining the area planted with improved seed and the area receiving fertilizer. In another study that investigated the adoption of use of single-ox technology, pesticide and fertilizer use, the dependent variable was the number of farmers using pesticide and fertilizer (Kebede, Gunjal and Coffin 1990).

In this study, we look at house holds harvesting rain water. Review of literature indicates that the main limitation is the product of 'hard' roof area per person (m^2) and expected annual rainfall (mm). To reach a World Health Organization (WHO) 'minimum' supply of 20 litres per capita per day where rainfall equals only say 800 mm/year needs about 9 m^2 of roofing per person. This level is not generally reached in poor rural areas or in multi-storey housing, despite the common tropical practice of having roofs overhang walls by 600 mm.

Studies indicate that a community that resides near water source will be less reluctant to adopt roof water harvesting technology for domestic use as opposed to one situated far from the source example is the study by Mahajan and Petersen (1985) which indicate that variation in domestic water consumption was directly linked to distance e.g. consumption of 2-3 litres per capita per day (lcd) for a source located 15 kilometers (km) away and 3-6 lcd for source 1 km away and 10-20 lcd for source next to the house.

The above literature shows that distance to the main water source does influence adoption of RWH. This study while appreciating the influence that distance is perceived to have on adoption of RWH seek to investigate if distance is also a factor that influence adoption of RWH in Kathiani and Kalawani division.

Throughout the developing world, studies indicate that men and women do not adopt new technologies at the same rate or benefit equally from their introduction. Review of studies on agriculture technology adoption shows that women in Africa continue to adopt high yielding varieties and improved management systems at low rates (Doss 2001). Recent empirical studies in Ethiopia (Tiruneh et al 2001), Ghana (Doss & Morris 2001) and Malawi (Gilbert et al 2002) document gender based disparities in adoption of improved technologies including improved seed, inorganic fertilizer, chemical insecticide etc. Furthermore, studies indicate that education and extension both play essential roles in determining adoption rates; however women's access to these valuable resources is often limited. A review of extension services in Ghana, Ethiopia, and India found that large gender inequalities existed in access to extension services (IFPRI and the World Bank, 2009).

Literature review indicates that men and women access to technologies differs, moreover women are observed to have limited access to extension services and education relevant to acquiring knowledge for new technologies. This study sought to examine if the same apply in Kathiani and Kalawani and build up and document material on the same subject.

Similarly, research on agricultural technology adoption (Adasen and Chianu, 2002; Herath and Takeya, 2003), the adoption of RWH is a complicated process that may be influenced by a set of interrelated biophysical, socio-economic, and institutional factors. The identified

potential explanatory variables include household factors, socio-economic factors and gender that are hypothesized to influence household adoption of RWH in the study area.

Socio-cultural norms

Socio-cultural norms and conceptions have an important role to play in determining women's access to and ability to use important technologies. Pender and Gebremedhin (2006) note that in Ethiopia strong cultural norms prevent women from plowing fields, thus disadvantaging women without adolescent or adult sons who must hire additional labor to plow her fields. In Nigeria, a pedal-operated, bicycle-mounted rice thresher was rejected by female processers because using the thresher exposed women's thighs and wearing trousers was not a culturally appropriate alternative in the region (UNIFEM 1993). In addition, perceptions that women are not "real" farmers may also impede women's access to credit, extension, and land (Doss 2001). As Doss (2001) notes in her review of designing technology for African female farmers, there is enormous diversity and complexity between different African villages, let alone countries, thus interventions that work in one context, culture or country very well may not in the next. These studies served to inform the implication of social –culture on adoption of RWH technologies.

Utilization of improved water supply is determined by people's beliefs (Davis and Garvey, 1993). Ordinary people, who are not specialist judge water purity by taste, color and smell, therefore its not rare to see some communities or country preferring dirty pond water because of taste example is study among the Bangladesh people (Chauhan, 1983).

One of the key factors in the success or otherwise of any water harvesting scheme is the perception of the users and the acceptability of the existing or proposed technology. It is important that the social and cultural aspects of water use is considered when planning and designing such systems (Jeffrey & Gearey, 2006) for instance cultural beliefs fundamentally describe the basic forms of behavioral attitude evolved by a people as they are taught to and learned by each succeeding generation [(Fedders, 1999 in Ngigi, 2003)]. Socio-cultural factors come into play in conceptualization of the resources of the environment and the use into which these can be put. Customs and beliefs about the storage and use of harvested water can act as a barrier to new sources of water and storage methods for example studies in

South West Uganda, villagers doubted the safety of water being stored in jars which were kept outside since they feared being poisoned; they also disliked the taste of water stored in cement containers (Anguria *et al*, 1994 in Thomas, 2001). Similarly, households in rural Zambia were reluctant to store water overnight because they feared spiritual contamination; as a consequence water left over at the end of the day was used for washing, watering plants or was even thrown away (Sutton, 2000 in Thomas, 2001).

The above literature shows the influence of culture on adoption of RWH and how perception by different groups determines the adoption of RWH technology, this study sort to establish if this is true in the study area.

The Universal Declaration on Human Rights affirms the principle of inadmissibility of discrimination and states "that all human beings are born free and equal in dignity and rights and that everyone is entitled to all the rights and freedoms set forth therein, without distinction of any kind, including distinction of sex" (Manase, Ndamba & Makoni, 2003).

Gender this is socially defined roles between men and women this study will look at how gender influence adoption of RWH for domestic use i.e. Do men and women have equal power to make decision about harvesting rain for domestic use? Domestic rain water harvesting includes water for cooking, drinking washing and kitchen garden.

2.3 Policy constraint to rainwater harvesting for domestic use

One of the main reasons for lack of support expressed in most National Water Policies towards RWH for domestic use is due to sectoral water development thinking. The old school theory of water development was unisectoral with least respect to other water sectors. With no competition for available water resources, this approach was sustained in the past. However, with increased socio-economic development, demand for fresh water has increased. To cater to the demand, most countries have adopted Integrated Water Resources Management (IWRM) strategies, which consider "water resources management" rather than "water Management".

Due to single sector development approach in the past, professional out look was limited to only surface and ground water development. This was highlighted as a policy constraint by the general secretary of the Kenya Rain Association (KRA), where he emphasizes the lack of trained and skilled persons in DRWH as a problem to promote the technology as a viable source of water supply.

Simplicity and community orientation of DRWH technology has also been highlighted as another constraint in developing DRWH. According to Wanyonyi (2002) the western educated professionals find it difficult to understand the appropriate technologies like DRWH for rural poor, thus, it becomes difficult to promote such technologies at national level.

The Building Code paragraph 251 (city council by-laws) in Kenya specifies action to be taken with respect to roof run off (Wanyonyi, 2002). The Building code specifies effective disposal of roof water but does not give any reference to storage and utilization of rainwater.

In other regions for example Thailand, the Thai Water Act, section 9, stipulates that anybody in possession of stored water during times of drought is expected to share it for public utilization. If unreasonable quantities are stored the minister or his representative has the right to take the surplus water for public utilization without any compensation to the owner of such water. Such punitive regulation can be hostile towards development of DRWH.

According to section 38 of the Thai Water Act, storage of water (including atmospheric water) for any purpose shall require a license

In Kenya Water ACT 2002, new strategies for management of water resources were developed; these approaches are bringing different stakeholders and mobilizing necessary resources which government is lacking. Rural communities are encouraged to form water users associations (WUAS) to assist in addressing their water needs; this is expected to improve access and fair distribution of water among different users. The Water ACT 2002 seeks to encourage private companies to provide water services, however, these companies are using the existing piped water supply systems, and so far these companies are not investing in new development of new water systems neither are they tackling issues of rural water supply.

In Kenya there are currently no clear policies on RWH, however in Kenya Water ACT RWH is mentioned in passing though, it has been associated more with integrated water resource management as means of availing more soil moisture for agriculture.

Summary of literature review

Literature reviewed demonstrated that rainwater harvesting is an ancient technology that has been used around the world for many centuries and continues to be used today, in developing countries this technology is restricted to rural areas with problem of water accessibility. The harvested water is used for potable application such as cooking and drinking. When it comes to quality it is observed that many rural communities around the world rely on harvested water for domestic use including drinking and cooking.

A number of barrier to the use of rainwater harvesting technologies have been raised they include financial constraint, gender role deferential, technologies such as poor installation of gutters, social factors and lack of sufficient storage capacity. Despite of all these challenges the high cost of supplying rural population with water from main system has not succeeded thereby forcing many to take up rainwater harvesting as alternative technology.

Lack of clear government policy guideline on the use of harvested rain water, and the supply for domestic use is attributed to limited adoption of RWH, despite slight mention of RWH in the Water ACT, there is no policy guideline in Kenya and the initiative has been left to community and non governmental organizations. The potential benefits of using RWH was identified they included saving women's time whose responsibility is to ensure availability of water for the family, water kitchen gardens and animals.

Gaps in literature on RWH

By examining various studies on RWH and adoption of technology, it has emerged that previous studies have concentrated on social and economic benefit accrued from harvesting rainwater; therefore most of the studies tend to highlight the benefits of adopting RWH either for agriculture or for domestic use. However, much has not been done in trying to identify how socio-economic factors will influence the adoption of RWH therefore this study sought to fill this gap. Moreover previous studies have concentrated factors influencing technology adoption when it comes to agricultural practices such as intensive agriculture, improved seed quality and use of organic fertilizers, this study therefore attempts to examine if the same factors will apply when it comes to adoption of RWH for domestic use.

In addition, the majority of technology adoption studies for agriculture have used aggregated data, particularly studies that analyze a large geographic region. Studies which use farm level data are limited. The use of farm level data instead of aggregate data can lead to significantly different conclusions (Rahm and Huffman, 1984). Farm level observations eliminate potential problems that may arise with aggregation bias and allow a greater number of human capital variables such as experience, health, and private and public information to be evaluated. The paper by Rahm and Huffman (1984) uses micro-data to analyze the adoption of minimum tillage technology by Iowa corn producers (Rahm and Huffman, 1984). This study used household level observation to analyze adoption of RWH.

CHAPTER THREE: CONCEPTUAL FRAMEWORK

3.1 The conceptual link between adoption of rainwater harvesting and socio-economic factors

Access to clean water at household level is fundamental to good health and driver of development in Kenya. Therefore, empowering household to access clean water is imperative especially when Millennium Development Goals (MDG) targets are considered. This study wishes to examine the relationship between adoption of RWH for domestic use and socio-economic factors that influence adoption. The use of harvested rain water is very important at household level as this improves access to water and releases household member to devote their time to other duties and development.

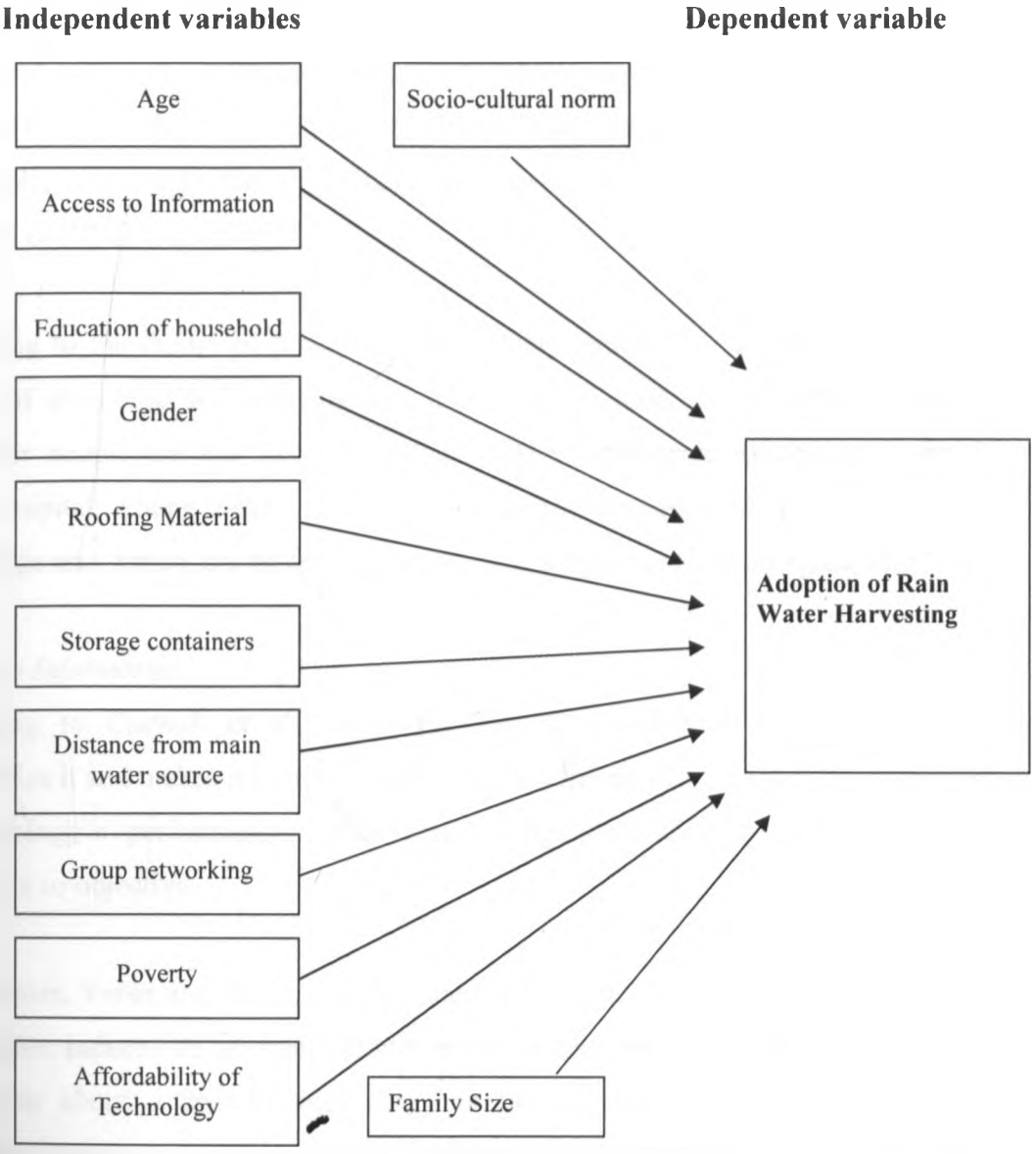
A variety of studies are aimed at establishing factors underlying adoption of various technologies. As such, there is an extensive body of literature on the economic theory of technology adoption. Several factors have been found to affect adoption. These include government policies, technological change, market forces, environmental concerns, demographic factors, institutional factors and delivery mechanism.

Selection of Variables

Variables used in the investigation were selected in relation to other adoption studies (Godoy et al. 2000; Sheikh et al. 2003), domestic knowledge of rainwater quality (Baguma et al. 2010), and household water demand, (The World Bank 1993). The analysis included explanatory variables hypothesized to influence households' adoption of RWH technologies in the study area, including a variety household characteristic, household perception, institutional and policy aspects.

The research Variables for this study are RWH adoption being dependent variable while the independent variables includes; Age, Gender, Education, family size, distance from main water source, group networking, farm size and wealth, roofing material Storage containers, access to information, affordability of technology, gender and culture.

Figure 4: Conceptual model of Rain water harvesting Adoption



Conceptual model of Rain water harvesting Adoption

Age of adopter

Age as a factor is thought to affect adoption. Age is said to be a primary dominant characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption. A study by Adesiina and Baidu-Forson, (1995) in Burkina Faso found that age positively influenced adoption of sorghum, while it also influenced adoption of integrated pest management on peanuts in Georgia (McNamara, Wetzstein, and Douce, 1991), and chemical control of rice stink bug in Texas (Harper et al., 1990). The effect is

thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In other studies, age was found to be negatively correlated with adoption or in some cases not significant in farmers' adoption decisions. An example is the adoption of fertilizer in Malawi (Green and Ng'ong'ola, 1993), age was significant, the question then arises will age be significant in adoption of RWH technology?

According to the theory of human capital, young members of a household have a greater chance of absorbing and applying new knowledge (Sidibé, 2005). Thus it is hypothesized that older people are less likely to adopt RWH technologies. According to the theory of human capital, young heads of household have a greater chance of being taught new knowledge and, hence, are better prepared for the adoption of technological innovations.

Access to Information

According to Caswell et al., 2001, gaining of information about a new technology demystifies it and makes it more available to users. Information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective.

Furthermore, Feder and Slade (1984) indicate how, if a technology is profitable, increased information induces its adoption. However in the case where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it.

Information is disseminated through informal sources like the media, extension personnel, visits, meetings, and farm organizations and through formal education. Thus its reliability, consistent and accuracy is important. Moreover, the right mix of information properties for a particular technology is needed for effectiveness in its impact on adoption.

Education and Adoption

Generally education is thought to create a favorable mental attitude for the acceptance of new practices, especially of information-intensive and management-intensive practices (Waller *et al.* 1998; Caswell *et al.*, 2001). What is more, adoption literature (Rogers 1983) indicates that technology complexity has a negative effect on adoption. However, education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption. Therefore as expected household's head level of formal education is the most important significant explanatory variable of the respondents' differential innovativeness. This is logical and consistent with the adoption theory and previous literature, as educated households head usually are associated with greater information on RWH measures, in adoption of RWH practices education is also found to positively affect the efficiency of technology use (Rahm and Huffman, 1984). When years of education of the household head in most adoption studies were considered, it was found that households with higher levels of educational attainment had a higher probability of adopting new technologies than less-educated households (Ramji *et al.* 2002; Tassew 2004). Education was expected to have a positive impact on adoption, however other studies such as study conducted by Asnake,et *al.* (2005) in Ethiopia showed that education had no significant effect on the adoption of improved chickpea varieties. In this study, adoption is hypothesized to be positively correlated with the household's education level

Roofing material

Roofing material and storage containers; this study examines the influence of availability of suitable roofing material on adoption of RWH it also looks at availability of storage containers these are also linked to the wealth of the households.

Farm Size

To a great extent, empirical adoption literature focuses on farm size as the first and probably the most important determinant. Farm size is frequently analyzed in many adoption studies (Shakya and Flinn, 1985; Harper *et al*, 1990; Green and Ng'ong'ola, 1993; Adesiina and Baidu-Forson, 1995; Nkonya, Schroeder and Norman 1997; Fernandez-Cornejo, 1998; Baidu-Forson, 1999; Boahene, Snijders and Folmer, 1999; Doss and Morris, 2001; and Daku, 2002). This is perhaps because farm size can affect and in turn be affected by the other

factors such as tenure thus influencing adoption. Farm size is also an indicator of economic level of a household and thus determines availability of wealth for adoption, meaning that a households' total land holding may serve as a good proxy for wealth status and income levels. This variable is likely to have a positive effect on adoption of most practices.

Family Size

Family size measures the size of the family. In this study family size was hypothesized to have a positive influence on the adoption of rainwater harvesting. This was mainly due to belief in rural areas where a large family represents social insurance (Gupta and Dubey 2006). Indeed, a large family is considered as a possible source of household specialties that could provide the household with unpaid labor or skills required for the adoption of technologies. Moreover, the study area is an agricultural area and this requires labor therefore in the study area, larger family size is generally associated with a greater labor force available. The larger the family sizes the greater will be the demand for water per household therefore rainwater harvesting would be more ideal to ease the task. In this study, it is hypothesized that family size has a positive influence on the adoption of RWH.

Storage of Rainwater

According to Fewkes (2006) a storage device is required to collect and hold catchment runoff because rainfall events occur more erratically than system demand. Water storage capacity is required in order to balance out the difference between supply and demand (Gould & Nissen-Peterson, 1999). Storage capacity of rainwater vary according to the nature of rainwater harvesting system, from the studies that have been carried out, literature indicate that RWH system with large water storage will perform better as compared to small storage for instance a storage of 500 litres jar will tend to overflow in wet season wasting up to about 70% of the water while it will run dry before the end of the dry season Thomas, (2006). Early study by Thomas indicates that majority of households do not store water outside the rainy season this is because of a number of reasons they include; the volume of water collected in one day is only sufficient to meet the immediate needs for that day, insufficient storage containers among many reasons, equally studies by Lundgren (2000) indicates that many households with a hard roof perform opportunist and informal DRWH. When it rains the people who practice opportunist DRWH tend use whatever containers they have at hand to collect roof

run-off. These containers have a capacity approximately ranging from 2 to 30 litres and include buckets, bowls, sauce pans, kettles etc. The yield of opportunist DRWH rarely exceeds 40 litres on a typical rainy day due to the absence of proper guttering and the limited water storage facilities. However it is important to note that the provision of water at the point of consumption from rainwater tanks provides a range of immediate positive social impacts on health, family welfare and domestic productivity. This results when time saved in water collection is utilized elsewhere. Some of the time saved maybe used for productive activities such as agriculture with clearly tangible and easily valued economic benefits. More time can also be spent on activities such as child rearing when women have time freed up from the daily chore of water collection. The value of such benefits to family livelihood and well-being are difficult to assess and are rarely appropriately valued. Dinesh (2004) states that: "DRWH can only help augment the basic water supplies where public water distribution systems are already in place and that too marginally." It's noted that DRWH systems also score low when it comes to terms of cost of production per unit volume of water, mostly due to the inconsistent high cost of DRWH components and systems.

Cost of technology

According to Caswell *et al*, (2001) the decision to adopt is often an investment decision. In agricultural practice this decision presents a shift in farmers' investment options when it comes to agricultural technologies. Therefore, adoption can be expected to be dependent on cost of a technology and on whether farmers possess the required resources. Technologies that are capital-intensive are only affordable by wealthier farmers (El Oster and Morehart, 1999) and hence the adoption of such technologies is limited to larger farmers who have the wealth (Khanna, 2001). In addition, changes that cost little are adopted more quickly than those requiring large expenditures; hence both extent and rate of adoption may be dependent on the cost of a technology. RWH must be economically feasible to the household. Cost of RWH need to be evaluated and compared with the cost of alternative water supply. The cost of catchment and storage depends on existing structures that can be used locally prices and additional building materials.(World Bank,1986) However the cost per capita of installing DRWH is generally somewhat higher than of supplying the same households from more traditional widely spaced point sources. In justifying DRWH it is therefore essential to take

into account the extra convenience it offers over point sources, by setting a value upon the time no longer spent on fetching water or queuing for it (Thomas, 2003).

Social-Cultural norms

Culture and community perception towards RWH for domestic use will also be examined i.e. how the community perceives RWH, is it valued or do they consider it tasteless like studies in Bangladesh where the community regarded rain water as not sweet. Perception was determined through direct questions on how the community values RWH as compared to other sources. Culture was also be examined against its influence on adaptive capacity of the community.

Gender role and influence on adoption of RWH

Evidence from throughout the developing world indicates that men and women do not adopt new technologies at the same rate or benefit equally from their introduction. Studies conducted on adoption of agriculture technologies note that women in Africa continue to adopt high yielding varieties and improved management systems at low rates (Doss, 2001). Recent empirical studies in Ethiopia (Tiruneh *et al* 2001), Ghana (Doss & Morris, 2001), Nigeria (Sanginga, *et al.,* 2007) and Malawi (Gilbert *et al* 2002) all document gender based disparities in adoption of improved technologies including improved seed, inorganic fertilizer, chemical insecticide etc. Would the same apply when it comes to adoption of RWH technology for domestic water use?

Furthermore, some technologies appear to be more easily adopted by women than others; however this varies widely based on context and culture. For example, in Bangladesh Hallman, Lewis and Begum (2007) find women are more easily able to adopt improved vegetable varieties for homestead production than group poly-culture fishpond technologies because the former activity does not require women to leave their homestead and potentially expose them to sexual harassment. Would the same apply to adoption of RWH given that it will not require women to leave their homestead?

The study looked at socially assigned role of men and women in relation to adoption of RWH for domestic use this variable was also examined in relation to men and women access to

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information on RWH technology. The crucial role of women in water resource management and therefore the need for their participation in water programmes have been recognized internationally. Women are the main users and managers of water resources therefore their involvement is essential in ensuring successful water management. A plan of action was adopted at the United Nations UN Conference on Women in Mexico (1975).

Fetching water and its management for domestic use is predominantly a woman's role with assistance of children. However, introduction of technology alters this through changing access to water source, or it becomes an income generating activity. Studies by Sutton (2000) shows that men have culturally kept off from fetching water due to the nature of containers used: pots and buckets. However, introduction of jericans has made it possible to carry the same on bicycles and carts as opposed to the head or back, which is seen as less dignifying

Water collection consumes a lot of time as the activity is carried out daily with several trips to the water point. Further more the task is physically demanding. The burden is further complicated by household size and activities such washing, cooking and bathing that are carried out at home and distance to the water source. A lot of studies show that it is women who determine which source of water to use, the amount to collect and coping strategy during times of shortage. However, the decision to install hard roofs is done by men.

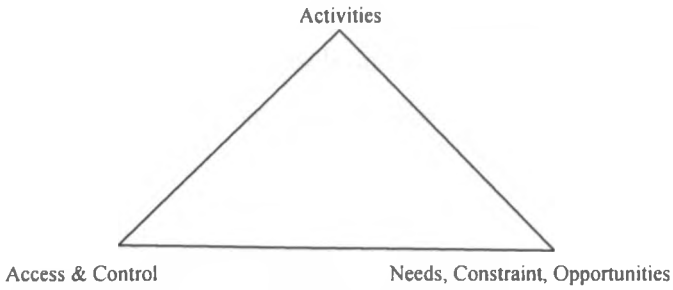
RWH empowers women, especially when there is an opportunity to use the time saved from fetching water in income generating activities. Gender role difference in determining resources for implementing DRWH could pose substantial obstacles to the process of implementing DRWH.

Use of RWH at the household level is minimal despite its existence for a long time. Many households are familiar with RWH and carry out opportunistic rainwater harvesting. (DFID, 2002). During the rainy season, however very few advance to permanent RWH where gutter and storage tanks have been installed. In his studies Mango (2002) highlights the role played by culture in the African communities' set-up. He emphasizes the importance of understanding the social organization of a lager networks and norms that govern their

relationship. Verma (2001) adds to this argument and points out some of the practices that marginalize women, limiting their access to resources, control of decision-making and equitable control of household resources, which is in turn influenced by societies construct gender roles within and between households resources, which is in turn influenced by societies construct gender roles within and between households.

Gender roles and responsibilities may partly account for lack of interest in permanent DRWH. Literature review indicates that women are typically found to have access to essential items for water fetching, namely tap stands, containers and storage tanks; in contrast men tended to have both access and control over the larger assets, such as roofs, means of transport, credit, meetings and information sources. Moreover, even though women are invariably cited as the main decision-makers regarding which water source to use and how much to collect, men usually took control of the decision to introduce permanent DRWH into the household. The exception is female headed households, where women would make all these decisions.

Figure 5: Social and gender analysis



Source: *Clare Bishop-Sambrook 2001*

Gender is a key issue in any analysis of poverty and water. Women disproportionately make up the poor and are the main managers of many water resources. Women face the burdens of fetching water for use in the home, of coping when there is not enough water for domestic needs, and of caring for those made sick by poor-quality water. Women are also often the main actors in productive activities around the home that rely on water vegetable gardens, livestock, handicrafts, and services (Soussan, 2004). Empowering women is critical to achieving more focused and effective water management. Successful empowerment will create an improved social and institutional environment for women that benefit many other aspects of life. Having in mind that gender and cultural issues directly relates with water provision for households, gender analysis was useful in this study in revealing potential biases and differences in the access, use and control derived improved water harvesting technology and to show how they influence the adoption of this technologies.

Group networking

Group networking is a form of social capital that involves interaction and interconnectedness in a society. It aggravates social participation such as membership in local organizations and has a positive relationship with the adoption of technology. Studies by Abd-Ella *et al.* (1981) and Korsching *et al.* (1981) observed that use of conservation practices in agriculture is influenced positively by group networking. Economic research on technology adoption and diffusion of innovation in rural areas has only partially addressed the issue of how interpersonal network exchanges affect adoption. Similar studies on adoption and diffusion build their modeling or empirical estimation on a very likely assumption: that neighboring agricultural households are, *de facto*, members of a social structure who exchange

information about improved agricultural practices. Yet much economic and non-economic research suggests that the characteristics of social structures are critical determinants of the way that information is diffused among households (Isahm, 2000). This study hypothesized that group networking will contribute to adoption of RWH.

Distance from main water source

Studies indicate that communities that reside near water sources will be less reluctant to adopt roof water harvesting technology for domestic use as opposed to those situated far from the source. An example is the study by Petersen (1985) which indicates that variation in domestic water consumption was directly linked to distance e.g. consumption of 2-3 liters per capita per day (lcd) for a source located 15 kilometers (km) away and 3-6 lcd for source 1 km away and 10-20 lcd for a source next to the house.

The study hypothesized that distance from household to the main water source increase the probability and intensity of adoption of RWH. This is because water is bulky and household will be willing to cut short this distance given alternative. Furthermore, collecting water from a distant source predisposed women (main water collectors) to harassment and also much of their need time is wasted.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction to Chapter four

This chapter shows how this study was undertaken; specific issues that were addressed include how data was obtained to answer the research questions, analysis and presentation. The chapter is divided into five sub sections these are: site description, pre field preparation, sample population, data collection and data analysis.

4.2. Site of Study

This study was carried out in Mavindu, Iveti and Kaani location in Kathiani and Kalawani division of Machakos district in Eastern province Kenya. Machakos district is located in Southern part of Eastern province of Kenya (figure 6); the district lies within the foreland plateau between Eastern Rift Valley and Nyika plateau. It lies between 0^{o} 45' and 1^{o} 30' South of the equator and longitudes 36^{o} 45' and 37^{o} 45' East of the Greenwich meridian. The district has an average rainfall of 750mm which is characterized by bimodal pattern with two distinct seasons; the long rains season between March and June and short rains between October and December. The district has inadequate water for domestic, livestock and crops. The rain is unreliable particularly in the dry months of July – September when the monthly rainfall is less than 10mm and people tend to be concentrated around water sources. The district is marginal with 75% of it falling below 800mm isoyet and 50% under the arid and semi arid agro ecological zones (Kimuyu, 1998). The district has 186,297 households according to 1999 census. Through consultation with District Water office the sample for the study was randomly selected from Kathiani and Kalawani[4] division, this was arrived at because of previous training on RWH for domestic use by catholic dioceses thereby providing ready availability of adopters and non adopters of RWH.

The divisions were selected for study not only for their semi arid environment characteristics in which sustainable access to water is challenging but also because of variable water sources available as indicated in study by Kimuyu (1998) the divisions experiences perennial shortage of water due to frequent droughts (Kenya, 2002).

[4] Kalawani is in lower Mbooni district currently no separate censors has been carried out

4.2.1.Population

The Population of Machakos District is estimated to be 416,410 in 2008 (Kenya, 2008) with a growth rate of 1.7% per annum. By the year 2012 this population is expected to increase to 465,756 assuming that the same growth rate persists (Kenya, 2008).

4.2.2 Terrain

The district topography rise from 700m above sea level on the south to 1,700m above sea level in the west, with numerous escarpments and hills the highest being kilimambogo which is 2,144m above sea level (Kenya, 2005). Huge proportion of machakos district is semi arid and receives very little and erratic precipitation. There are two rainy seasons the long rain which falls between March and May and the short rains falling between October and December, the annual average rainfall falls between 500-1300mm (Kenya, 2002). However during the period of research short rains were less than the norm of the study area. The main sources of water are Rivers, wells boreholes etc. by reviewing Machakos district development plan it was observed that rainfall in the district is inadequate while water from permanent rivers and dams had not been fully harnessed. The use of roof catchment to harvest rainwater was mentioned in the 2002-2008 district development plan as one of the measure required to improve the water supply situation in the district.

4.3 Pre Field Preparation

Prior to departure to the field, the researcher developed a focus group discussion guide both founded on specific questions of the study (appendixes). A questionnaire was also developed in advance for the purpose of enlisting socio-economic and cultural characteristics of the household heads as well as their demographic background. Along side questionnaires observation sheet was used, probing questions were asked and response recorded. Secondary data was obtained from publications, government documents, journals and other related research finding on the same subject. In this study both qualitative and quantitative data collection approaches were used. Quantitative aspect being dynamic and interactive generates more detailed data that leads to in depth understanding of the context in which the phenomenon under takes place while qualitative approaches made possible the generation of the salient background characteristics of the study population.

4.3.1 Field Exercise

The researcher started by introducing herself to the household, clearly explaining to them the purpose of the study, the time she will spend in their midst administering the questionnaire. this was followed by supporting her authenticity for the exercise by showing clearance letter from the university.

4.4 Sample population

According to Smet (2003), the greatest RWH technology has been achieved by using individual household for management, the household was therefore selected as unit of analysis, data was then obtained from household survey. The study targeted household head; both adopters and non-adopters were interviewed. A total of 77 respondents were interviewed. The sample population comprised of households from Kathiani and Kalawini division, focus group discussion and key informants. The divisions were selected for their pre-eminent position as the intervention sites and also due to their higher population densities compared to other areas.

Table1: Household headship among respondents in Kathiani and Kalawini division

Headship	Frequency	Percent
Male headed HH	58	75.3
Female headed HH	19	24.7
Total	77	100.0

Most of the household interviewed were male headed 75.3% and only 24.7% were female headed.

4.5 Sampling Procedure

The unit of analysis for this study was individual households. The divisions were estimated to have 95,000 people (District Development Plan, 2008). From this I targeted a sample of 77 households evenly drawn from the two divisions which was assumed to be sufficient for statistical inference using the central limit theorem for representative large

population sample sizes (n≥30) (see also, http://thismatter.com/money/insurance/law-of-large-numbers.htm).

Being aware that data gathered from individuals tend to be inconclusive given the difficulty which may arise from sources such as interpretation of questionnaire items or situation biases (Smith and Kemp 1998), the structured questionnaire was administered personally via face-to-face interviews with each informant. The administration of the personal survey took considerably greater time and effort, but made it possible to confirm the identities of the respondents and to ensure that the questions were understood. These factors contributed to greater data accuracy and reliability.

The study intended to pick every 10^{th} household as literature had indicated that the two divisions have high population densities; this was only possible in Kaani sub-location as it had feeder roads to get to the homes and the homes were not sparsely distributed. To get to the rest of the respondents without being bias, the researcher used systematic random sampling applying a simple formula of approaching the 3^{rd} household after the last. To establish random start, we drew a lottery to accomplish this, the researcher had five pieces of paper each numbered and folded. The papers were put in a container then one paper was picked and whichever number was in the paper marked the household that would be the first respondent.

Due to proximity to election of 2007 most household heads were concentrating around shopping centers and markets and therefore the researcher moved to the shopping centre where they were converging, to ensure that the study did not end up with people from the same area three different markets were visited.

Besides household survey, two focus group discussion were held they constituted early adopters both male and females and none adopters, key informants were also interviewed and the result were used to augment the findings. The first focus group discussion took place in Makogeni in Kaani while the second one was held in Mbooni. An arrangement was made to meet at a nearby market the objectives of the discussion was explained to the participants, its was made clear that there are no wrong and right answers and all were

allowed to give their opinion, after self introduction the discussion started with the assistance of an interpreter.

4.6 Data collection

The data collection methods included administering household survey questionnaires, key informant interviews, focus group discussions as well as field observations, (refer to appendix for sample questionnaire and interview guides) conducted in Kathiani and Kalawani division. Most of the data, quantitative and qualitative, were collected from both primary and secondary sources. The secondary data was from books, journal articles and other relevant publications from the internet. These provided useful information to ground the study and understand the problem better.

The following are the key information that was required to answer specific research questions:

a) What are the socioeconomic factors that influence the adoption of RWH for domestic use?

In order to address this question on adoption of RWH for domestic use, the following information was required; source of income, distance from main water supply, knowledge of RWH technology, cost of buying water, Family size, farm size, group networking, education of household head, availability and size of storage containers, availability of hard roof surface, problems faced in managing storage containers.

b) What are the sources of water in the district?

In order to address this question on sources of water in the study area the following information was required; sources of water for household during wet season and dry season, distance from the main sources ands cost associated with a given source.

c) Influence of traditional gender role of men and women in determining of RWH technology

To address this question on gender role and adoption of RWH for domestic use the following information was required; who decide to invest in RWH, whose role is it to supply household water.

The following table was useful in relating research objective with the method used to collect data. It shows the various variables that were examined to answer each of the research objectives.

Table 2: Data collection techniques

Research objectives:	Method of data collection	Data needs
To establish the main sources of water in the study area.	Interviewing household heads randomly selected using structured questionnaires Key informant Interviews Observation	• Households sources of water • Distance to water source • Who collects water • Cost of water
To find out socio- economic factors that influences the adoption and sustained use of RWH at household level.	Household head interview Interview with key informant Focus group discussions interview	• Age of respondent • Education attainment • Sources of income • Family size • Access to information • Roofing material • Size of storage containers • Group networking • Technology affordability
To examine the influence of traditional gender roles on the adoption of RWH technologies	Household head interview Interview with key informant Focus group discussions interview	• Sex of household head • Social cultural norms • Who makes decision when investing in RWH • Whose responsibility to collect water

Source: own illustration

4.6.1 Survey

This was carried out using questionnaires with both closed and open ended questions. The questions were grouped under the following themes;

(i) General information including socioeconomic details

(ii) Availability of structures such as storage tank, gutters hard roof etc

(iii) Gender role, decision-making and RWH

The questionnaires were administered to household in the two study sites.

According to Leedy and Ormrod (2001), "Research is a viable approach to a problem only when there are data to support it". Nesbary (2000) defines survey research as "the process of collecting representative sample data from a larger population and using the sample to infer attributes of the population" The main purpose of a survey is to estimate, with significant precision, the percentage of population that has a specific attribute by collecting data from a small portion of the total population (Dillman, 2000; Wallen & Fraenkel, 2001). In this study, primary data was sourced through field survey; this method was used due its suitability and relevance to the problem at hand. From review of literature Fowler (2001) points out that numerous facts about peoples' behavior can be obtained by asking a sample of the said population. Therefore survey was important in getting views of the households who were targeted with regard to RWH, the household was chosen as the unit of analysis as it still remains the primary social and economic institution where resources are organized and allocated to meet basic needs. (Wilk, 1996). The survey involved administering questionnaire to 77 households in Kathiani and Kalawani division of Machakos district.

4.6.2 Interviews

The second part of the primary data was acquired through interviews with key informants. This included officials from World Vision and Catholic Dioceses of Machakos. These key informants had participated in one way or another in RWH training of the community. The basis of their selection was their ability to provide information on socio-economic influence and other factors related to this study. Two interviews were

conducted using semi structured interview to allow for discussion, a great extent of qualitative view was given.

Key informant interviews: These were conducted to specifically generate detailed information about RWH. A total of two key informants were interviewed, they comprised of development officer from world vision development office, development officer from Catholic dioceses of Machakos. The key informants were selected purposively due to their expert knowledge and general experience in RWH. The interview was carried out with the aid of an interview guide, information obtained was meant to compliment findings from survey.

Focused Group discussion: Two of them were conducted to generate detailed information that was to be used to explore broadness of issues. The one conducted in Kaani had sixteen participants while the one from Mbooni had ten participants. These discussions generated detailed information on issues related to research questions, they were meant to compliment findings from households. The findings were also used to explore the broadness of issues, just like key informants, participants were picked purposively based on their experiences on RWH. The discussion was guided by the interviewing guide with open ended questions corresponding to the research theme. Focus group discussions are seen as an important tool for data collection due to their nature which allows an outsider to quickly understand range of perspectives playing key role in the community. The focus groups were led by a facilitator (researcher). Each had 8 and 14 people respectively. This is as recommended by Fowler (2001). For both FGD similar topics were discussed, including sources of income in relation to RWH, culture, gender, storage containers, water sources distance e.t.c.

4.6.3 Ethical Considerations

As this study required the participation of human respondents, specifically household heads, certain ethical issues were addressed. The consideration of these ethical issues was necessary for the purpose of ensuring the privacy as well as the safety of the participants. Among the significant ethical issues that were considered in the research process include

consent and confidentiality. In order to secure the consent of the selected participants, the researcher relayed all important details of the study, including its aim and purpose. By explaining these important details, the respondents were able to understand the importance of their role in the completion of the research. The respondents were also advised that they could withdraw from the study even during the process. With this, the participants were not forced to participate in the research. The confidentiality of the participants was also ensured by not disclosing their names or personal information in the research. Only relevant details that helped in answering the research questions were included.

4.6.4 Limitations/Challenges

A number of challenges were experienced during this study, this included the challenge of identifying households that could meet the study criterion, this was due to the absence of official list of households both adopters and non adopters of rainwater harvesting technology. To address this, the researcher sought for the service of a community trainer of water harvesting from Catholic Diocese who knew the location and adoption status of most household in the study area.

Second initial data collection exercise coincided with the 2007 political campaigns for the general parliamentary elections in the country and in some occasions arrival of prominent politicians would draw all the potential interviewees to the political rally and this delayed the survey process as a result focus group discussion could not be held until after the elections were over.

The participants for the focus group discussions were purposively selected following interviews and discussions subsequently held with households heads. Two focus group sessions were held, the first one comprised of adopters and non adopters while the second one comprised of majorly adopters.

4.7 Data Analysis.

The responses that were completed in the questionnaire were first checked for presence of inconsistence, where this was detected cleaning was done. The responses to the open ended questions were examined with a view to evolve a pattern on the basis of which the corresponding was developed to keep them at par with structured questions. The responses were then entered into social science statistical package (SPSS) computer windows, frequencies and graphs were then derived, the findings were presented in tables, charts and graphs for discussion.

Whereas, qualitative data acquired from focus group discussion, and observations was sorted out, organized, ordered, described, summarized and interpreted based on the objectives and research questions in order to complement the statistical information. Generalizations and inferences have then been made for the entire population of the study area.

CHAPTER FIVE: FINDINGS AND DISCUSSION

5.1 Introduction

The discussion in this chapter presents the description of characteristics of respondents interviewed which included their age, sex family size and education. In addition findings and discussion on socio-economic factors influencing adoption, sources of water in the study area and role of gender are discussed.

5.2 Socio-economic characteristics of households

Demographic Characteristics of informants

The study focused on household heads who often happen to be men but ended up with more women than men. The sample had 62.3% of the respondents being women and 37.7% were men. This could be explained that due to drought, most men had moved out to look for employment outside to support their families and therefore most of them were not at home during the day when data was being collected, in addition, data collection coincided with the 2007 parliamentary general election campaigns period and most male were away attending campaign rallies, therefore most of them were not at home during data collection. However during focus group discussion issues that were unclear during household survey were raised and clarified in the focus group discussion

Age

The age of the sample population varied and it was observed that the age of respondents from the interviewed households ranged between 19 years and 68 years with a mean of 35 years with male being slightly older (36years) than female (35years). The study result shows that 45% of the respondents' interviewed were between the age bracket of 19-30 years and 31-40 as 31%. Age also assist in determining if a respondent is of age to participate in the interview. Table 3 below gives a summary of age distribution of respondents. Very few respondents (9%) were 51 years and above an age that is considered risk evasive or not strong for manual work.

Table 3: Distribution of respondents by Age

Age of respondent	Frequency	Percentage
19-30	35	45.5
31-40	24	31.2
41-50	11	14.3
51-60	5	6.5
61-70	2	2.5
TOTAL	77	100

Source: computed from field data 2007/2008

Age is said to be a primary latent characteristic in adoption decisions, and was therefore considered significant in this study as it shows whether the respondent is in the productive bracket or dependant. In this study majority of the respondents were within active age bracket of 30 -50 years meaning that they could easily participate in the introduced technologies on RWH. In this particular study age was not significant in adoption of RWH. However, an interaction with the community representative through focus group discussion indicated that individuals from household participate in construction of tanks for harvesting rain water by providing labor, this means that the elderly in the population will not be able to offer the much needed labor thereby missing an opportunity of owning a tank through community effort.

Households Size

The household is the key unit of production, reproduction, consumption, and decision-making on pooling and allocating labor and resources (Hordijk, 2000; Mwangi 2002). Field findings found that the mean no of children per household was 3 children while the mean house hold size was 6.8. Family size below 5 was considered small while 6-10 is medium and above ten is large.

The size of a household is an important factor in determining water needs in a household, majority of the respondents had a mean of 6.82 people per house which ranges from 1 to 15 persons. The effect of the family size on the household's adoption of RWH system is expected to be of two folds. First, as the family is the source of farm labor and farming demands more labor, larger families are expected to be more innovative than small

families to meet their food demand, since large families will require more water, they are expected to adapt to RWH to improve accessibility and release more family members for subsistence production. The study found out that in household with more family members that are dependants' children or elderly, the access to water is strained as few members are left with the responsibility of supplying water to the rest of the household. This variable also assumes that larger households will require more water as opposed to smaller households' size.

Education

In this study, the respondents were found to be fairly educated by attainment of primary, secondary and college level education. It was observed that only 2.6% did not have education at all, 36.8% primary level, those that had secondary education and above were as follows; 32.9% secondary level and 27.6% college level. Table 4 below gives the summary, generally the study population was observed to have the basic education.

Table 4: Distribution of sample population by education attainment.

Education level	Frequency	Percent
None	2	2.6
Primary	28	36.8
Secondary	25	32.9
College	21	27.6
Total	76	100.0

Source: computed from field data 2007/2008

By cross tabulating the data on level of education and decision to harvest rain water from the roof top the findings are summarized in the table 5 below.

Table 5: Cross tabulation of education and RWH from the roof

Crosstab

			collection of rainwater from the roof		
			yes	no	Total
education	none	Count	1	1	2
		% within collection of rainwater from the roof	1 4%	20.0%	2.7%
	primary	Count	27	1	28
		% within collection of rainwater from the roof	39 1%	20.0%	37 8%
	secondary	Count	23	2	25
		% within collection of rainwater from the roof	33.3%	40.0%	33.8%
	college	Count	18	1	19
		% within collection of rainwater from the roof	26.1%	20.0%	25.7%
Total		Count	69	5	74
		% within collection of rainwater from the roof	100.0%	100.0%	100.0%

Source; field data 2007/2008

However, to be able to relate education and harvesting of rain water a cross tabulation of education and capacity of storage containers was done as indicated in table 6 below. It was observed that those with no education and those with least level (primary) were not harvesting rainwater and were only using opportunistic harvestings indicated by the capacity of the containers with 0-200 litres (drum and other small containers) on the contrary those who were harvesting above 10,000 litres had secondary school education and above.

Table 6: Cross tabulation of education and capacity of storage containers in Litres

		0-200	201-500	501-5000	5001-8000	above 10,000	Total
education	none	1	0	0	0	0	1
	primary	16	5	4	1	2	28
	secondary	9	3	6	0	5	23
	college	6	1	8	1	3	19
Total		32	9	18	2	10	71

Source; field data 2007/2008

In any given community, education is important for human resource development. Education is vital in empowering people. It plays key role in improving the status of a

given community (Pandey, 2006). A well educated population is perceived to be well informed and able to grasp new ideas fast. Education has a function of transmitting skills, knowledge, norms and values from generation to generation and formalization of appropriate social perspectives. Research hypothesized that socio-economic characteristic of households such as education influences their adoption of technology. Nonetheless, the result from this study showed that there was no direct relationship between level of education and adoption of RWH. The study was trying to determine role of education in improving the adaptive capacity of the community as seen in the reviewed literature, however from the correlation tabulation,

Roofing Material

The study also analyzed the relationship between education and selection of roofing material, iron sheets were observed to be popular across all levels of education, table 7 below gives a summary of the outcome.

Table 7: Cross tabulation respondent level of education and roofing material

material for roof		Respondent level of education				Total
		None	primary	secondary	College	
	iron sheet	2	26	22	19	69
	Tiles	0	0	3	1	4
	Grass	0	1	0	0	1
	makuti	0	1	0	1	2
	Total	2	28	25	21	76

Source; field data

This reveals that education was not significant in choosing roofing material. The study found that the distribution of roofing material in the study area was as follows; nearly 90% of the respondents had corrugated iron sheet roofing, 6.1 % space tiles and remaining soft roof. Roofing material is key when it comes to adoption of RWH the material used will determine quality of water available for harvesting and if harvesting can be carried out. From the field observation iron sheet was the most common material for roofing regardless of the education of the respondent.

Studies elsewhere have noted that Iron sheet provide efficient runoff suitable for harvesting, similarly tiles produce relatively clean water while soft roofing are not ideal

for rain harvesting (Harden, 1987). From this study, it was realized that availability of corrugated iron sheet was not a limitation as 89% of the household were observed to have iron sheet roofing. Such roofing gives a clear picture of potential for rainwater harvesting for domestic use. However, despite the availability of suitable roofing material ideal for rainwater harvesting a number of challenges were realised which inhibit rainwater harvesting, first it was observed that majority of the household (51.6%) did not have proper structures for collecting water such as gutters and in cases where they existed they were not fitted all around the roof for maximum collection. Upon probing the same from the key informant on the reason for limited adoption besides availability of ideal roofing material, he said that cost is the main reason most households cannot afford to invest in RWH structures.

Leaking and improper fixing was another challenge that was observed leading to lose of water from the roof. The same was echoed during focused group discussion whereby the community lamented that most community shared tanks. were loosing water due to cracks resulting to leakage and in cases where they were not leaking poorly fixed gutters hindered maximum water collection from rain. This agrees with the reviewed literature whereby Thomas (2006) sites that failure of guttering as a common cause of failure of RWH. This study observed that availability of catchment area alone is not sufficient but there is also need for technology to harness the available water for instance, sufficient storage capacity, gutters and piping system. Though it was established that majority of the households had iron sheet roofs which are considered ideal for harvesting rainwater, this on its own did not amount to household harvesting water it was established that there is need for technology improvement through investing in gutters, and storage tanks for it to be successful.

Source of Income (farm size)

When asked about their main source of income most of the respondents, 45.5% identified farming as their main occupation, with 18.2% saying they were teachers and 14.5% identifying themselves as casual labourers. A further indication that the levels of income were generally low was the fact that, although farming was their main activity, 63.2% of respondents said they had 3 acres or less each. Regardless of the fact that farming was

cited as main source of income by 45.5% of respondents', the average size of farm was found to be relatively small with, 63.2% of the respondents having an average of 3 acres or less each. Very few households had farm size of 7-10 hectors 6.6%. See table 8 below.

Table 8: Size of the farm

		Frequency	Percent
Valid	0 to 3	48	63.2
	3 to 6	23	30.3
	7 to 10	5	6.6
	Total	76	100

Source: computed from field data 2007/2008

The study established that majority of household rely on farming as source of income meaning that, limited access to land by some reduced their opportunity to raise income for investing in RWH, this also has implications when it comes to gender and access to land, women are noted to utilize land for subsistence farming to provide food for their families, while any production that raises income goes to men therefore for income generated from farming to be invested in RWH, thus men need to be fully involved and convinced to invest in RWH. The size of the land is related to economic ability of the household, most of the household with small acreage cited poverty and financial constraint in acquiring structures for harvesting water for domestic use.

The study further found out that many respondents felt that cost of RWH structures restricted its adoption, this was particularly emphasised when they had to choose between buying food during dry season and investing in RWH structures, there was an outcry particularly by focus group members who emphasised the need for external funding. Affordability is key when it comes to rainwater tanks initiatives for households, there are many households from developing world who could benefit from rainwater harvesting through upgraded roofs and tanks, however, cost has prohibited them this is clearly shown by numerous homes where rainwater is collected by insufficient technology such as pots, buckets, old oil drum etc. In the case of this study 49% of the household were observed to use pots, old oil drums and other kitchen containers, most respondents cited cost as the limitation to acquiring a tank. From this study, It was observed that small

incomes, together with limited access to credit facilities, mean that household expenses is under stress and purchase of essentials such as food and medicine, and the payment of school fees are more important than long-term investments, such as the installation of a DRWH-system. The high capital cost, or the expectation of high cost, coupled with lack of information about low cost alternatives, is one of the major factors inhibiting a shift from opportunist DRWH to informal or formal DRWH

Storage Devices

The study observed that the majority of households' surveyed (73%) do not store water outside the rainy season. They gave a number of reasons which included;

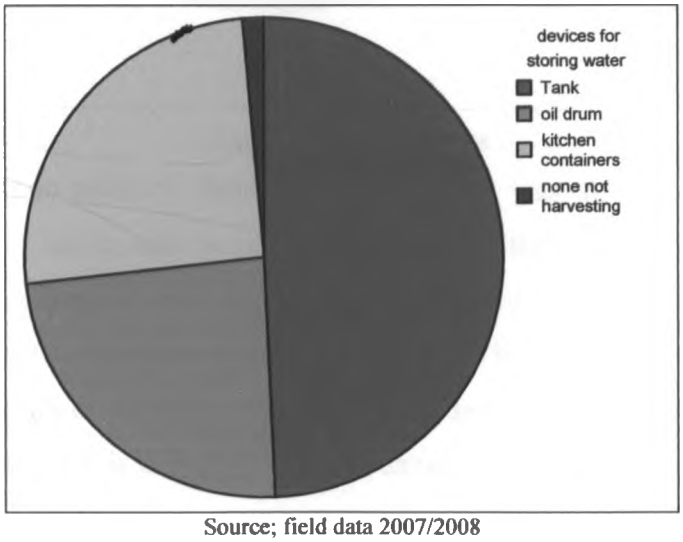
(i) he volume of water collected in one day is only sufficient to meet the immediate needs for that day,

(ii) Insufficient storage containers and

(iii) The water source is close to the house.

The main storage devices were found to be small kitchen containers with majority of households using opportunistic harvesting. The distribution was found to be 23.9% oil drum, 25.4 % kitchen containers, 1.7% not harvesting at all and 49% cement tanks. The study observed that majority of the households do not have sufficient storage containers to store harvested water from the roof.

Figure 7: Distribution of water storage containers

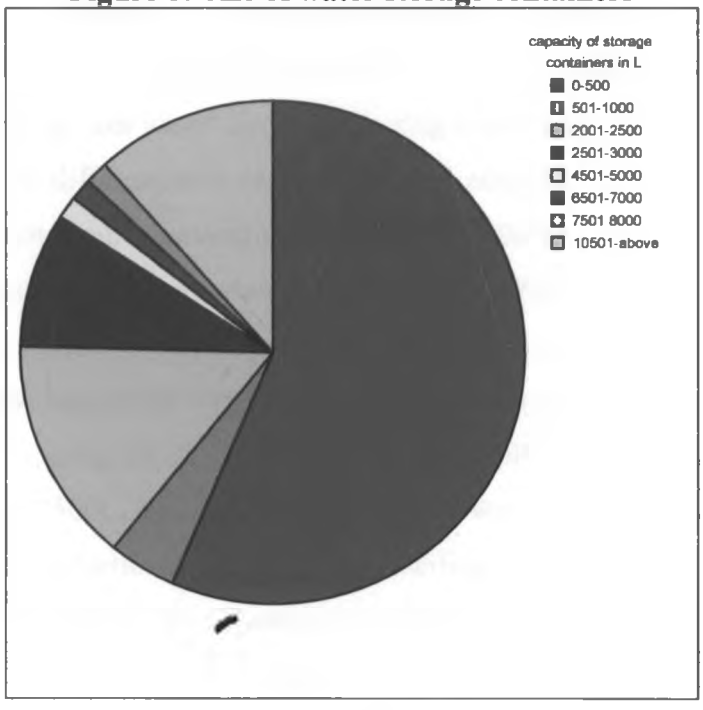


Source; field data 2007/2008

Capacity of storage containers

The study found out that majority of the household interviewed had water storage capacity of 500 litres and below, very few households were observed to have storage capacity of above 10,000 litres see figure 8 below. This was attributed to cost as only a few had tanks that could hold large volume of harvested water. The storage capacity was also used to distinguish those harvesting rainwater from opportunistic harvester, those who were practising RWH had averagely big capacity storage containers compared to those who were using kitchen containers and oil's drums as storage devices.

Figure 8: Size of water storage containers



Source: field data 2007/2008

The duration of time taken to finish harvested water was almost equally distributed ranging from days, weeks and months. It was shown that the stored water for some respondents lasted only for a few days while for others it lasted for several weeks. This was related to the size of storage containers available to households. Only a little over 1% (1.4%) of respondents could store enough water to last them the whole year. The latter also confirmed that there is enough rainfall to satisfy domestic water requirements for a year.

Table 9: Duration of water storage among respondents

Duration of water storage	Frequency	Percent
Days	25	35.7
Weeks	20	28.5
Months	24	34.9
Year	1	1.4
Total	70	100

Data from the field 2007/2008

Storage capacity was significant as it has key role when it comes to adoption of RWH. The variable was also important in assisting to differentiate adopters from non adopters, some opportunistic adaptors who use all sort of containers to trap water from the roof claimed to be harvesting rain water but by analyzing availability and size of containers the adopters could be differentiated easily from non adopters. Availability of storage containers will promote more harvesting of roof water. Besides availability of storage containers, the capacity is very important if adoption of RWH is to succeed. Most of the families interviewed indicated that they were not able to harvest water to last beyond a month, majority of the household were observed to be harvesting capacity of 0-500 litres (figure 8 in page 51) using oil drums and small tanks followed by arrange of storage capacities from 2001-2500L, the main challenge that was cited in the study area was meeting the cost of construction of water storage facilities. According to the focus group participants harvested water last between four and six months if its only used for drinking, further probing indicated that most of the tanks fill up with two night rains showing that a lot of water goes to waste as rain water in not maximally harvested during rain season due to limited storage facility a few of the tanks were observed to have capacity of 15,000 litres. The study found that some households who harvested water indicated that they largely use it for drinking purpose only one of the respondent from focus group discussion said that 'I *draw drinking water from the tank every evening and lock the tank with a padlock I cannot send a child to draw water because they will waste*' this emphasised the importance of clean harvested water for drinking. From the observation most of the respondents' tank capacities were small as majority of them

mentioned overflowing of water tank after two to three down pour during wet season where as the same tanks will run dry before the dry season is over, this observation agrees with argument by Thomas (2006).

Further more, considering that the mean household size was observed to be 6.8 then capacity of 200 litres using oil drum is no where near meeting basic need, minimum requirement being 20 litres per person per day from a source within one kilometer of the users dwelling (WHO, 2000 and UNICEF, 2000) this means that storage capacity of 200 is only enough for a day and half household needs.

Cost/Affordability

The study observed that most of the responded were buying water at an average of Ksh10 and this is thought that it would challenge many to construct or buy water storage tanks to reduce cost but this was not the case. Most were forced to buy because of lack of alternative or as the only source of clean water. Results indicate that most households purchased water, on further probing during FGD indicated that this was expensive for them considering that they are subject to drought and in many occasion they need to buy food. 88% of the respondents were found to be buying water only 12% were not buying.

Cost of buying water

It was observed that most of the household interviewed buy water at some point, among those interviewed; it was observed that 48.1% buy water at Ksh 6-10 or more. The table 10 below gives summary of water pricing in the study area.

Table 10: Price per 20 litre jerican (Kshs)

Price	Frequency	Percent
0-5	26	33.8
6-10	37	48.1
11-15	3	3.9
16-20	11	14.2
Total	74	100.0

Source; field data 2007/2008

The study established that low income of the most households has led to limited adoption of RWH technologies in the area. This was due to prevailing poverty in the area, attempts

to solve this are hindered by scarcity of financial services institutions that household could rely from. Therefore, it was established that financial constraint hindered most of the household from harvesting water as they cited lack of finances to install gutters and buy or construct tanks for harvesting water; besides storage capacity it was observed that many of the responded who claimed to be harvesting rain water were opportunistic harvesters utilizing kitchen and other small containers thereby limiting the water that could be stored this confirms observation from the earlier literature reviewed on the same where Thomas (2006) agues that 70% of water is lost in wet season when small containers are used and the water stored end up drying before end of dry period.

Table 11 below gives a summary of association between distance to the main water source and price of water. From the table we can see that majority of the respondent 36 0ut of 77 covered a distance of 2-3 km, buying water at a range of Ksh 0-5 and Ksh6-10, prices increase with distance but at some point this changed since the water source was from communal source such as dam and therefore the respondent considered it free since time spend was factored in monetary terms.

Table 11: Cross tabulation of price per 20ltr jerican and distance from the main water source

		distance from the main water source					Total
		0-1	2-3	4-5	6-7	8-9	
Price per 20l jerican	0- 5	9	12	3	1	1	26
	6 -10	11	21	4	1	0	37
	11-15	1	1	1	0	0	3
	16-20	5	2	1	2	1	11
Total		26	36	9	4	2	77

Source field data 2007/2008

Technology

This study also established that lack of sufficient and appropriate technology derailed adoption of RWH for instance improperly installed gutters, absence of storage containers or leaking storage tanks limited adoption of RWH besides this, it was established from focus group discussion that leaking tanks was a major problem to the community and this

was associated with reducing ration of cement to sand to cut cost , in the process the quality of the water tanks was poor and lost water through leakage.

The study established that many households with a hard roof perform opportunist and informal DRWH. When it rains the people who practice opportunist DRWH use whatever containers they have at hand to collect roof run-off. These containers have a capacity approximately ranging from 0 to 500 litres and include drums, small tanks, buckets, bowls, sauce pans, kettles etc. The yield of many opportunists DRWH rarely exceeds 40 litres on a typical rainy day due to the absence of proper guttering and the limited water storage facilities this observation agrees with study by Kiggundu (2004).

From the focus group discussion it was realised that most of the participants contributed cash to construct water tanks; however, contribution was not sufficient to purchase materials for constructing the tank in addition to the food shortage, meant priority is given to getting food as opposed to purchasing material for tank construction.

Decision-Making

In Kaani area it was observed that there is sufficient rain at any given area and a homestead with tank capacity of 25-30m3 is sufficient to supply water for the whole year. The long rains start from October to January while short rains from late March to late May. However, decision on water source to use is still determined by a number of factors, the main one according to the community being affordability of material for RWH tanks, according to focus group discussion, most of the respondents understand the benefits of harvesting rainwater but they have difficulty in raising funds to purchase water tanks.

5.3 Sources of Water

The sources of water are important in determining how water will finally be used in the household. This formed the basis of the first objective of this study as it sought to establish the various sources of water for the people of Kathiani and Kalawani division in wet and dry season. Under sources of water, the study examined the following variables; sources of water in dry and wet season, distance of household from water source, available options of water source available and reason for selecting specific source, by examining these variables the study sort to understand variables that are key to a household when it comes to deciding the source from which to get household water needs.

Source of water in the study area was regarded as an important variable as it would determine the need for RWH. The study found that rainwater was cited as a source only during the wet season. This was an indication that many households had iron roofs, ideal for RHW, however many of those interviewed were practising opportunistic harvesting, not realising that RWH had the potential to take them much further with proper storage containers. This implies that if they were provided with sufficient information and means to increase storage, many more households would make more efficient use of the rainwater, to last them far into the dry season.

Table 12: Cross tabulation of the main source of water in wet season and division of respondent

Division of respondent	Source of water in wet season								
	river	RWH	dam	protected spring	unprotected spring	well	bottled	RWH & Well	Total
Kalawani	5	30	2	3	0	3	0	0	31
Kathiani	3	20	2	1	1	5	1	1	26
Total	8	50	4	4	1	8	1	1	77

Source; field data 2007/2008

Table 12 shows that the highest percentage of (64.9) depended on RWH during the wet season followed by well and river at 10.4%. This can be explained by the fact that in wet season most households harvest water from the roof. However for those using water from wells and rivers, this could be attributed to some households not harvesting water due to

lack of proper roofing materials or lack of storage facilities. However upon probing to find out the amount of water harvested in relationship to storage containers, the study realised that majority of the household carry out opportunistic harvesting with utensils and small containers or oil drums 51% while the rest of the households 49% have sizeable water tanks. Despite having suitable roofing materials ideal for harvesting rainwater, most of the storage structures were observed to be small with capacity of 200 litres. However by examining the various sources of water in dry season, it emerged that the 41.6% of households depended on river followed by well at 25.9%, showing that the community was not harvesting rain water to last up to dry season. In both divisions, river was the main source of water during dry season; the study observed that there was great shift in sources of water with season.

Table 13: Cross tabulation main water source in dry season and division of respondent

Division of respondent	river	RWH	dam	pond	protected spring	unprotected spring	well	others	Total
Kalawani	20	1	4	1	3	2	6	1	31
Kathiani	12	1	2	0	4	3	14	3	26
Total	32	2	6	1	7	5	20	4	77

Source: 2007/2008 field data)

Choosing water source

Gaining insight on various water sources was seen important in this study as it would assist in understanding if a given source supports adoption of RWH. Findings from the survey indicated that communities use a range of criteria to determine their preferences for water sources (see Table 13); a given source is picked depending on the basis of a number of issues, the most important of which were found to be such as proximity, accessibility, and quality of the water are the most important.

Moreover, other sources such as river, spring, dam. well and borehole were cited, all these together with RWH were considered relevant for supply of water for domestic use, however several factors were found to influence source of water at a given time such as cost in case of RWH and storage containers needed, distance and time wasted to collect water from the river, well or spring, accessibility particularly where a water source is

shared with animals, cleanliness etc all this influenced the decision to use water from certain sources. A good example is purchase of water either from vendors or water kiosk, despite being expensive as cited by the respondents, this source was considered clean for cooking and drinking and therefore attracted many. This emphasises the importance of accessing clean water by households.

5.3.1 Problem of water access

This study observed that respondents face a number of water related problems as summarized in table 13, 47.3% of the respondents cited distance as one of the water problem they faced and also water being dirty. Most of the respondents (93%) felt that accessing water in the area was a problem while only 7% felt that it was no longer a problem. Table 14 shows the number of respondents and what they perceived to be the problem with accessing water from their sources. The main problem noted was distance covered to access water. This could be attributed to the fact that permanent rivers were very few and therefore the respondents had to travel long distance to access water. Dirty water was also a problem with most people complaining about going for long distance to access it, this could be attributed to sharing the same source with livestock and other uses making it dirty for domestic use.

Table 14: Cross tabulation whether water access is a problem and what makes it a problem

	Elaborate the problem						
Is domestic water supply a problem	Very far	Expensive	dirty	far & dirty	river dry up in dry season	domestic animal demand a lot of water not enough	Total
yes	35	7	13	13	3	1	72
No	0	0	1	1	0	0	2
Total	35	7	14	14	3	1	74

Source; field data 2007/2008

There is great shift in water sources during different seasons for instance it was observed that the proportion of households for whom roof catchment are main water source in dry season is very little 2.6% while river accounts for 41.6% and well for 26% meaning that the households tend to go to open water source during dry season, these sources have

relatively poor quality water and are more prone to contamination and waterborne diseases.

Reasons for choosing water source

Households' choice of water source is generally determined by proximity to water source both in wet and dry season. However the reason given by most respondents was that of availability and also not costly and time saving, the two accounting for 31.5% and 28.8% respectively, other reasons given included accessible 16.4%, near 4.1% , and no other option 19.2%. Discussion with the participants from focus group discussion indicated that they cover a distance of 4km to get water from the well, one lady commented that *''I would rather go for 4km and fetch water immediately rather than going to a well which is ½ km away and queue for three hours while waiting for my turn to get water''* this means that in some case distance was ignored if the nearest water source meant that household will queue for long time to get water. This area was observed to have several massive tanks that are shared communally with the water being harvested from the hills nearby however, at the time of the focus group discussion most of the tanks were dry, this was attributed to many people sharing the same source, upon probing the community said that some were leaking leaving just a few operational.

Buying water

The study found that a fairly large percentage (87%) of the household buy water at some point, the cost ranges from Ksh3 to Ksh20 per 20 litre container with a mean price of Sh 9.40, some of the respondents buying water felt that water access was a problem as some had to walk long distances to get water kiosks and they needed money to buy the water which was a challenge to many to get.

Table 15: Number of Households buying water

Buy water	Frequency	Percent
Yes	67	87.0
No	10	13
Total	77	100.0

Source: computed from field data 2007/2008

During focus group discussion it was observed that in Kaani, during dry season the respondents were buying water at Ksh10 per 20 litres, they indicated that they would like to save this money as it is hard to come by "*There is drought and we would prefer to use the little money to buy food and not water*" said mama Elizabeth, this therefore indicates that rainwater harvesting still remain a better option as opposed to covering long distance in search for water. RWH could be an option to minimize this cost by reducing the amount of water purchased.

The cost of water bought by most respondents ranged between Ksh. 5 to Ksh.10 per 20 litre jerican with majority buying at Ksh.10 per 20 litre jerican as indicated in table 16 below.

Table 16: Cross tabulation of problem in domestic water supply and price per 20ltr jerican

	price per 20l jerican								Total
problem in domestic water supply	0	3	5	6	10	12	15	20	
yes	7	1	13	1	34	1	3	11	71
no	1	0	1	0	1	0	0	0	3
total	8	1	14	1	35	1	3	11	74

Source: computed from field data 2007/2008

Majority of those interviewed gave two main reasons as to why they buy water; the purchased water is clean 43.1% and lack of alternative source 40.3%. This could be attributed to very few permanent rivers in the area and the few open sources that are there are shared with livestock making them unsuitable for domestic use. This study therefore observed that there was shortage of clean water and therefore the community was forced to buy water from water kiosk, on probing further the respondents indicated that households would like to install large capacity tanks to supply clean water and reduce their expenditure in buying water.

Table 17: Reason for buying water

Reason	Frequency	Percent
It is clean	31	43.1
No other source	29	40.3
Not applicable	6	8.3
It is cheaper	2	2.8
Substitute what is there	2	2.8
River dries' up	2	2.8
Total	72	100.0

Source; field data 2007/2008

Distance to the main water source

This was important in understanding the distance covered to access water and time, this will in turn help in determining the need for RWH as availability of water source within the homestead will not motivate households to invest in RWH. The study found that only 33.8% of the respondents could access water within 0-1 km which is the recommended distance, 46.8% of the respondents had to cover a distance of 2-3km to get water while the rest had to walk for 4km and above to access main water source. The table 18 below shows the frequency distribution of the distance the respondents have to cover to the water point. It was observed that the mean distance to the permanent water source was found to be 2.7km with shortest being 100m and longest being 8km. this can be explained by the fact that little has been done in the area to improve on water provision and people still walk for long distances to get water this is similar to a study by Speelman et al (2006) whereby there study found out that their respondents in Machakos district walked between 50m to 7km to get to water point.

Table 18: Distance from the main water source to homestead (km)

Distance	Frequency	Valid Percent
0-1	26	33.8
2-3	36	46.8
4-5	9	11.7
6-7	4	5.2
8-9	2	2.6
Total	77	100.0

Source: computed from field data 2007/2008

In an attempt to determine if distance from the main water source influences adoption of RWH, this study examined the relationship between distance from the main water source and the adoption of RWH. It was observed that despite the distance from the main water source 14.3% of the respondents interviewed had adopted RWH with storage capacity of 15,000 litres and above, 25.7% had water storage capacity of 2300- 5000 litres however majority of the respondents 52.9% were not harvesting and this is shown by capacity of their storage containers which was 500 litres and below meaning they were carrying out opportunistic harvesting during rain season but could not store water beyond rain season the table below summarizes the findings.

Table 19: Cross tabulation of distance from the main water source and capacity of storage containers in litres

Capacity of tanks		0-500	1000.00	2300-5000	6900-8000	15000 and above	Total
Distance from the main water source	0-1km	11	1	2	0	3	17
	2-4km	24	1	15	2	3	45
	5.and above	2	1	1	0	4	8
Total		37	3	18	2	10	70
Percent		52.8%	4.3%	25.7%	2.9%	14.3%	100%

Source: computed from field data 2007/2008

5.4 Gender and Rainwater harvesting

The study found out that the responsibility of collecting water for household use is largely on women as follows: wife 68.8 % daughter 7.8% son 3.9 % with little support coming from father 5.2% and casual labourer 6.5%. In addition, the study also

established that in the majority of the respondents interviewed the decision to invest in rainwater harvesting structures lies with the husband who is the household head see summary in the table 20 below.

Table 20: Decision to adopt RWH

		Frequency	Valid Percent
Valid	Wife	8	14.5
	Husband	37	67.3
	Both	10	18.2
	Total	55	100.0

Source; field data 2007/2008

In this study, gender was considered important as it play key role in determining adoption of RWH, the study looked at this variable in relation to men and women role in household water supply, decision-making in investing RWH and water source and use management. It was also found that in the majority of the households (67.3 %), the men are responsible for home development and therefore the decision of investing in storage tanks was under the men, majority of whom are the household heads, this therefore means that the men need to be convinced of the benefit that will be accrued when women's time spend in fetching water is reduced. Furthermore, the role of water collection is in the docket of women and therefore investment in this technology will depend on how men are involved in the sensitization of the need for alternative water source to argument available water and save the time wasted in collecting water from long distance source. Comment by one lady was ''*men love themselves once they get home they want to bath and eat its none of their business where water come from*''

From the summary on table 20, its clear that the responsibility of household water collection is under women (mother) meaning that any meaningful attempt to address the challenge of water accessibility will need to include women for it to be successful, when this is compared to the person responsible for home development and thus investment in RWH it was observed that men (husbands), they are responsible for decision-making when it comes to home development, however it is the responsibility of women to decide water use in the home this is attributed to being their responsibility culturally (27%) and also 23% of the respondents said that women are always at home compared to men. Gendered division of responsibilities in the community emerged as a challenge to

adoption of RWH technologies, as water for household use was the responsibility of women while decision for investment in major RWH are made by men. Therefore decisions to invest in RWH technology will require convincing men the benefits of saving time spend in fetching water. Men were not entirely opposed to the adoption RWH technology however there is need for clarification of the importance for them to invest in it.

It was important in this study to understand decision-making and gender within the household to get clear insight on its influence in investing in RWH structures. The table below gives a summary of the persons who make decision when it comes to adoption of RWH, these findings agree with Mr Anditi key informant from World Vision who said that in cases of male headed household, initiative for major RWH systems such as plastic tanks with capacity above 5000 litre are spearheaded by male/ husband while for smaller volumes women are majority in initiating them especially through their community groups. Furthermore, an interview with key informant indicated that where RWH initiative emanates from household , mostly it is the women who initiates the process, but since most of them lack adequate resources, then adoption is low but in cases where initiative comes from outside e.g. from development or government organizations then there is a high adoption by households who are member to the outside initiative and also those with resources, therefore the non member and those financially unable are cut out majority of whom are women. Decision to use particular water source is a utility function according to micro-economic theory consumers who choose such qualities of goods and services that maximises satisfaction provided they keep within the budget constraint. According to Tsur and Dinah (1997) the combined effect of improved lifestyles, growing population and diminishing water supplies are assumed to exacerbate competition for water resources, however for rural households in this study utility pursuits are not conventional since other limitation are put in consideration. They include household labour that is distributed among activities such as farming, firewood collection among others. This variable demonstrates extent of inclusiveness and exclusiveness and indicates any gender inequality. Access to clean water has direct impact on quality of life in a population but women are mostly affected due to their cultural role of supplying

water for use in the household. Therefore adoption of RWH reduces women work and saves time spend in collecting water.

Group Network

The upsurge of women groups indicates the attempt to overcome the marginalization of women in terms of labour and resources, women contribute money to a common pool which members borrow at minimal interest that is agreed upon, this gives them opportunity to gain access to resources that can in turn be invested into acquiring rain water harvesting structures such as storage facilities. Of the 77 people that were interviewed, 63.6% of them knew of existence of groups that support rainwater harvesting out of this only 40.8% belonged to such a group and mentioned education and promotion of rainwater harvesting as key objectives of the groups.

During tank construction labour was contributed by the members, one participant from focus group said ''*those who isolated themselves do not have tanks because they loved themselves and didn't want to get tired*'' This effort was realised through community group. Upon probing it was realized that gutters are fixed on one side of the roof as tanks are small and fill up quickly therefore no need to cover the whole roof area. Further interview with key informant indicated that communities who have development group or government organized organization then initiatives in RWH adoption is skewed to those communities with adequate resources or those who are group members in case of groups.

Formation of Water Resource User Association (WRUAs) has improved the capacity of community to access information and adoption RWH. The community has attempted to adapt through initiatives like women groups to collectively acquire tanks. Findings from focus group discussion indicated that belonging to a community. group enabled one to acquire skills in water tank construction and maintenance; it also provided opportunity for central consolidation of funds for construction of water storage tanks for households on rotational basis.

5.5 Conclusion of Findings

The analysis of adoption of Rainwater Harvesting practice led to the following results; Adoption of RWH is affected both by characteristics of household and the resources they own. First, the results from this paper indicate that RWH adoption should incorporate consideration of household head, age, size of the household and education. Many of the earlier efforts to promote RWH are based on purely technology and economic characteristics. Variables such as roofing materials, sources of income, storage devices, capacity of storage and cost were significant in adoption of RWH.

The first objective was to establish the main sources of water. The study found that the main source of water was RWH in wet season only while the river and wells were main sources of water in dry season. This shows that there is need for more interventions to enable harvesting and storage of harvested rain water to last till dry season.

In addition, gender was observed to be key in influencing RWH adoption whereby women had the responsibility of collecting water for household use while decision to invest in water storage and collection structures such as gutters tanks is the responsibility of men, therefore for adoption to succeed one has to understand the role of gender. The findings also lead to the conclusion that group network plays major role in adoption of RWH, it was observed that through initiatives such as women group households were able to gain skills, information, collective labor, consolidation of funds for water Storage tanks.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The study examined the relationship between household adoption of RWH technologies in Kathiani and Kalawani division, and the influence of independent variables (such as age, years of education, household income, household size, roofing material, cost of technology, gender and group networks). It explored the impact of sources of income, education, culture, gender and social processes in adoption of RWH technologies and the role and society expectations of men and women.

The data for the study was gathered through both observations of households in the study area, interviews with household heads, focus group discussions and key informants. A checklist was developed in the form of a questionnaire and was used to ensure that socio-economic and cultural aspects of the respondents were captured. The information obtained was screened and analyzed by use of SPSS, while information from focus group discussion was transcribed and analysis carried out along the subject area as stated in the objectives.

6.2 Conclusions

The literature review in this study revealed that, the fundamental's issues in adoption of RWH includes; availability of suitable roofing materials, capacity of storage containers, household income and access to information, in addition adoption literature indicated that education and age positively influence adoption of technologies. Education was therefore observed to influence adoption of RWH positively, whereby households head with higher level of education had large water storage tanks (above 10,000 litres) where as those with lower education were observed to practise opportunistic harvesting with capacity of 200 litres.

In addition this study found out that the main source of income for or respondents was farming, however, upon examining their farm size majority were found to have relatively small farm size with 63.2% having a mean of 3.6 acres this translates to limited resources available to the households for adoption of RWH, thereby deducing that limited resources

played key role in limiting adoption of RWH. Therefore, financial constraint was cited as a major drawback when it comes to constructing tanks for harvesting rainwater. Most households would prefer to use their resources to get food rather than install water tanks for rainwater collection.

This study observed that the majority of the households had iron roofed houses but were not harvesting water from the roof as indicated by uninstalled gutters and lack of storage tanks for harvesting water. This was attributed to poverty whereby there was lack of resources to install the structures. Lack of sufficient income was therefore found to hinder adoption due to limited resources available for investing in RWH structures, such as tanks, gutters and in some cases roofing material. Absence of sufficient facilities to support maximum harvesting of rainwater from the roof was also noticed. Most homesteads had gutters on one side of the roof for harvesting rainwater while water from other sides was lost and could not be harvested. When asked why, the respondents attributed it to lack of sufficient funds to purchase gutters for the whole roof area.

Gendered division of responsibilities in the community emerged as a challenge to adoption of RWH technologies. Water for household use was the responsibility of women, while decisions for development are made by men. Therefore, decision to invest in RWH technology will require that men be convinced of the benefits of saving time spent fetching water. While the men were not entirely opposed to the adoption of RWH technology, there is need to clarify to them the importance of investing in RWH.

The gender differences in controlling resources and decision-making can pose substantial obstacles to the process of implementing DRWH systems. Men may need to be convinced that reducing women's workload through improving water collection in the home should be priority expenditure. Men and women will often see the benefits of rainwater collection differently, and neither may value the particular advantages that planners imagine to be important.

6.3 Recommendations

Rainwater harvesting can be an excellent technology to augment household water supply in dry areas with scattered households. However, the study found out that, for it to be adopted, a number of social and economic factors need to be addressed and therefore policies aimed at promoting DRWH should be designed carefully taking socio-economic aspect into consideration.

The following recommendations are based on the results of this study

1. Gender and age dimensions should be incorporated in strategies for adopting technology as the study fond that women and Girls are left with the responsibility of supplying household water for the family.
2. The study recommends that institutions be put in place to assist households to access funds for rainwater harvesting structures; such assistance should include subsidized material.
3. The study recommends that institution to work with the local community or households to provide guidance on right size of water storage tank to enable storage of water to last up to dry season.
4. There is need to improve access to water by reducing the distance covered to get water for domestic use.
5. This study further recommends that research be carried out on cost benefit analysis of rain water harvesting structures to inform the relevant government institution on best way forward.

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Appendices 1

Household head questionnaire on Roof water harvesting in Kathiani and Kalawani division –

Identification details

1. Questionnaire No	
2. District	Machakos
3. Division	
4. Location	
5. Sub location	
6. Name of Interviewer	
7. Date of interview	
8. Name of respondent	

9. Household head 1 MHH□ 2 FHH□

Introduction to the respondent
My name is Joan Kariuki, a student at University of Nairobi Pursuing a master's course in Development studies. I would like to ask you a few questions on Rainwater harvesting for Domestic use, you do not have to answer any question you do not wish to answer the questions will take about 40 min. After the question you can ask any question that you wish to ask, your name will be held in confidence and will not appear on any report that will be developed

Part ii Demographic details

10. Age _____

11. Sex

1 male	
2. female	

12. Marital status

1. single	
2. married	
3.Divorced	
4.widowed	

13. Number of children living with you

14. What level of education did you attain?

1. none	
2.Primary	
3. secondary	
4. college	

Section iii Household Economic

15. How many people live in your household? ----------

16. Farm size _____

17. What is your occupation

1.Farming	
2.Teaching	
3.Trade	
4.Casual labour	
5. Other	

18. What material is the house built from? Observe and record

19 (a)Walls?

1Mud and poles	
2 Wood	
3burned brick	
4 stone4 cement	
5cement blocks	

(b) Floor?

1Earth	
2wood	
3 stones	
4 cement	

5 brick	

(c) Roofing?

1 Iron sheet	
2 Tiles	
3 Grass	
4 Makuti	
5 Others specify	

Section B water sources
Collection and use of water

19. Which is your principle source of water in (a) wet season?

1 River	
2 Rainwater Harvesting	
3 Dam	
4 Pond	
5 Protected spring	
6 Unprotected spring	
7 Well	
8 Other specify	

20. What are the reasons for using the source mentioned?

(b)In dry season

1 River	
2 Rainwater Harvesting	
3 Dam	
4 Pond	
5 Protected spring	
6 Unprotected spring	
7 Well	

8 Other specify	

21. What are the reasons for using the specified water source List

1. ----------

2. ----------

---

22. Whose job is it to ensure that there is water for household use?

1 Mother	
2 Daughter	
3 Father	
4 Son	

Others_____

23. Why is the responsibility of collecting water assigned to the person named above?

_____

_____

24. In your view does this influence adoption of RWH technology?

_____

_____

25. Are there other sources of water accessible to your household

1.Yes	
2. No	

26. If yes what are they?

_____

_____

_____

27. What are the reasons for not using these other sources?

---

28. What is the main means of collecting water in your household?

---

29. Are there other means of collecting water in your household?

1. Yes	
2. No	

If yes specify

1Carrying on the head/Back	
2 Bicycle	
3 wheelbarrow□	
4 Donkey□	
5 Handcart□	

Others specify ----------

---

30. What is the distance of the main water source from the household? -------KM or -----M

31. In your opinion is there problem with domestic water supply in this community?

1 yes	
2 No	

32. If yes what is the problem?

1 Very Far	

2 Expensive	
3 Dirty	

Others specify□----------

---

33. Do you ever buy water?

1 Yes	
2 No	

34. If yes why?

1 It is cheap	
2 No other source	
3 It is clean	
4 No time to fetch water	

Others specify□ ----------

---

35. . How much do you pay for a 20 litre Jerican
36. If no what measures have you taken to ensure constant supply?

Section C: Rainwater harvesting use

37. Do you collect rainwater from the roof when it rains?

1 Yes	
2 No	

38. If yes what are the devices used for storing harvested rainwater?

1.Tank	
2.Oil Drum	
3.Kitchen containers & buckets	

Others specify_____

39. If no to question no 37 go to question no 68 (non adopters)

40. How long do you store the water

1.Days	
2.Weeks	
3.Months	

Other specify□

_____

_____

41. What is the capacity of your storage container in Litres

_____

42. What is the main use of harvested rainwater in your household?

_____

_____

_____

43. List how harvested rainwater is used at home in priority (Rank 1-5 with 1=MOST 5= LEAST)

Uses of water at home	Which activity uses most water1= most & 5= least	Which activity is most important 1=most	
Cooking & Drinking			
Washing clothes			
Cleaning the house			
Bathing			
Livestock			
Vegetable gardens			

44. Who decides how rain water is to be used in the household

1 wife	
2 Husband	
3 anyone	

45. How does this influence the utilization of harvested water?

---

46. Is harvested rain water accepted for household use in this community?

1 Yes	
2 No	

47. If No Why?

---

48. If yes why?

1 Clean	
2 Near saves time	

Others specify□----------

---

49. Have you taken any other steps to ensure that you do not experience water shortage in the course of the year?

1 Yes	
2 No	

50. If yes in the above what steps have you taken?

---

51. How has adoption of RWH changed your life compared to when you had not adopted?

---

52. Are you able to collect almost all rainwater obtained from the roof?

1 Yes	
2 No	

53. If no to the above what are the limitations?

.....

.....

.....

54. If yes how do you achieve this? ----------

---

55. What benefit has your household acquired from harvesting water?

---

56. Are the benefits mentioned more than the cost accrued when you were acquiring the tank? Elaborate ----------

---

---

57. Are their groups that have been formed to address access to clean water in this area?

1 Yes	
2 No	

58. If yes to the above are you a member of such a group that aims to improve access to clean water in this area?

1 Yes	
2 No	

59. If yes what are the objectives of the group

1----------

2 ----------

3 ----------

60. Does the group promote adoption of RWH?

61. How? _____

_____

62. How have you benefited from the group?

_____

_____

Gender and water harvesting

63. Who makes decision on the adoption/construction of water harvesting tank?

1 Wife	
2 Husband	

Others specify

_____

64. Why is the decision made by the person named above?

_____

_____

_____

65. Does the person who makes decision in any way limit adoption of RWH?

_____

_____

66. Do men and women have equal access to information when it comes to RWH technology?_____

_____

67. How does this influence/limit the adoption of RWH for domestic use?

_____

Non Adopters

68. Why are you not harvesting rainwater for domestic use? _____

_____

69. Do you have any interest in adopting RWH?

1.yes	
2.No	

70. If yes explain what has constrained you from adopting?

_____

_____

71. If no to question 63 give reason for not being interested in adopting RWH technology?

_____

_____

72. In your opinion do you think adoption of RWH will improve your life? Explain

_____

_____

73. Has access to technology influenced your access to RWH technology?

1. yes	
2. no	

74. If yes elaborate

_____

_____

75. Is there any other reason why you have not adopted harvesting of rain water?

1 Yes	
2 No	

76. If yes elaborate ----------

Does your culture in any way influence the adoption of RWH for domestic use?

1 Yes	
2 No	

If yes explain

_____

_____

Gender and water harvesting

77. Who decides on the adoption/construction of water harvesting tank?

1 Wife	
2 Husband	

Others specify

_____

78. Why is the decision made by the person named above?

_____

_____

_____

79. Does this in any way limited adoption of RWH?

_____

_____

80. Do men and women have equal access to information when it comes to RWH technology?_____

_____

81. How does this influence the adoption of RWH for domestic use? _____

_____

82. In your opinion what should be done to improve adoption of RWH by many households? _____

83. In your opinion what do you propose should be done to increase adoption of RWH technology by households in this community? ----------
---
---

84. Do you have any question ?

Appendices 2

Focus group discussion

Setting up for discussion and introduction

- Organize the venue where to hold the meeting, get the group details before the meeting start and use that time also as ice breaker after introducing self and interpreter
- Allow the respondent to introduce themselves
- Introduce the project and agenda of the day the focus on RWH and socioeconomic issues
- Let the participants know that there are no wrong and right answers on an issue
- Let them know its okay to have different opinions and all are free to participate

Information guideline question

1. Can we talk about factors that influence the adoption of RWH for domestic use in this community? (list all mentioned)
2. I would like to know your opinion on why some people have not adopted RWH for domestic use?
3. Does the role of men and women influence the adoption of RWH differently?
4. Who initiate the use of RWH technology to provide domestic water and does this influence its adoption?
5. Let us now talk about cultural practices that influence the adoption of RWH? If there are any
6. Does adoption of RWH for domestic use bring any benefit?
7. What is the distance to the nearest water source when not using harvested rain water km (note different estimate given)
8. Social process that influence capacity to adopt RWH GROUP SME
9. Elaborate on the challenges that you face when trying to adopt RWH technology
10. Any other comment on adoption of RWH for domestic use?

11. Given the option of RWH and water from other sources which one will you prefer and why?
12. What is the main challenge when it comes to adoption of RWH for domestic use?

Information source

13. How did u access information on RWH for domestic use? Do men and women have equal access?

Appendices 3

Discussion guideline with Key informant
Date of interview _____
Name of Respondent_____
Organization_____
Role in RWH_____

1. From your work what factors have you observed to be influencing the adoption of RWH for domestic in households?
2. What is your opinion as to why some people have not adopted RWH for domestic use?
3. Does the role of men and women influence the adoption of RWH differently?
4. Who initiate the use of RWH technology to provide domestic water and does this influence its adoption?
5. Are there social process that you have observed playing role in influencing capacity to adopt RWH e.g. Women group a
6. Elaborate on the challenges that households face when trying to adopt RWH technology

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