FACTORS INFLUENCING RAINWATER HARVESTING TECHNOLOGY IN NORTH NYAKACH LOCATION, KISUMU COUNTY, KENYA

BY

MAURINE RUTH ATIENO OJIL

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SCHOOL OF ARTS AND SOCIAL SCIENCES

MASENO UNIVERSITY

ABSTRACT

In Kenya, where a large part of the population live in rural areas and rain fed agriculture is the main livelihood, droughts and floods have far reaching impacts on communities. One form of mitigating the negative effects of drought is the implementation of simple, small-scale, low cost schemes called rainwater harvesting. This involves the capture, storing and redirection of rainfall. However this technology has very low adoption rates. In the few cases where it is practiced rainwater is harvested in small quantities to be used for domestic purposes, in addition the quantity collected is not sufficient to last beyond the rainy season. While irrigation may be the most obvious response to drought, it has proved costly and can only benefit a fortunate few. Rainwater harvesting therefore provides a low cost alternative, which if adopted by local communities would significantly improve yields in agricultural activities. The focus of this study therefore is to assess the factors that influence adoption of rainwater systems as a viable source of water for agricultural use among residents of North Nyakach Location, Nyando District in Kenya. The specific objectives are to establish the nature of rainwater harvesting technologies in North Nyakach location, to analyze the socio-cultural factors influencing rainwater harvesting for agricultural use and to analyze the challenges facing rain water harvesting technologies in North Nyakach location. The methodology of the study involved survey research design in which data was collected using questionnaires and interviews, supplemented by secondary data sources. The study covered 108 randomly selected households in in North Nyakach Location and the unit of analysis was a household. Data was analysed using descriptive statistics which included frequency tables. The Statistical Package for Social Sciences (SPSS) was used to compute the statistics. The study established that rain water harvesting technology had not been adopted by majority of residents in North Nyakach location, gutters directed to upper tanks form the most popular system by users of the technology, iron sheets were the most common roofing material, fathers were the main decision makers with regard to installing rain water harvesting systems and they own the land on which the systems are installed, finally residents quote lack of funds to install and maintain systems as the most common challenge. It was hoped that the results of this study therefore would be useful for farmers, development practitioners, policy makers, and other stakeholders interested in adopting a different approach to agriculture with potential to produce better yields.

CHAPTER ONE

1.1 Overview

This chapter contains the background of the study, the statement of the problem, objectives of the study, research questions, significance of the study, limitations of the study and theoretical framework

1.2 Background of the study

In Kenya, where a large part of the population resides in rural areas and rain fed agriculture is the main livelihood, droughts and floods have far reaching impacts on communities. One form of mitigating the negative effects of drought is the implementation of simple, small-scale, low cost schemes called rainwater harvesting. This involves the capture, storing and redirection of rainfall, runoff, and groundwater. Rainwater harvesting for agricultural use is a technology, which has not been embraced by local communities (Nigigi, 2003). Rainwater harvesting involves collection of precipitation on the roofs of buildings and other surfaces, which is either stored for later use or recharged to the ground aquifers. The water needs to be directed from the roof via gutters and conduits to a storage facility or another medium for ground water recharging. Through this simple technique, one can meet all, or at least a substantial amount of one's need, from the free gift of nature. Rainwater is naturally soft and readily usable for many purposes (Integrated Development Africa Programme, 2010)

Rainwater harvesting provides the long-term answers to the problem of water scarcity. It offers an ideal solution in areas where there is sufficient rain but inadequate ground water supply and surface water resources are either lacking or are insufficient. It has a strong environmental benefit, which justifies implementing such a system. By re-using rainwater, the demand is reduced on regions with already scarce water resources. It reduces the volume and velocity of runoff generated in specific areas. In turn, this reduces the potential for floods downstream. Reducing runoff volume and velocity also reduces the amount of pollutants from impervious surfaces entering downstream water-bodies (Integrated Development Africa Programme, 2010). From one rainwater harvesting storage structure can arise a myriad of interrelated activities including kitchen gardens, poultry keeping, zero grazing, biogas digester installations, manure harvesting, drip irrigation for horticultural crops production and fish farming among other economic activities. All these activities have a projection on increased income generation, improved nutrition status, improved sanitation and personal hygiene, creation of on-farm employment leading to poverty -reduction and conservation of the environment (KRA, 2009). Compared to the conventional systems of water supply for domestic consumption, agriculture, industrial and other uses that emphasize abstraction from surface streams, deep wells and even the seas, rainwater is much cheaper, as it requires minimum treatment and needs little if any reticulation systems. It is paradoxical however, to allow rainwater to flow over the surface of the earth and cause environmental disasters such as the negative impacts of flooding, landslides, and soil erosion while it is possible to harness it for use in households, agriculture, and industrial as well as for livestock and environmental improvement. (Nigigi, 2003).

Out of Kenya's population of approximately 38 million, a considerable portion (75 %) is living in rural areas where rain fed farming and livestock keeping are the main livelihoods (UI, 1999). Moreover, Kenya's population is increasing at a rate of 2.6 %/year (World Bank, 2010). There is a high level of dependability on the seasonal rains. Kenya is classified as a water scarce country with annual water supplies below 1000 m3/person (UNEP, 2002). The situation is predicted to worsen drastically within the near future. In semiarid regions temperatures are projected to increase and precipitation decline by 2030 due to climate change (Malesu, Oduor & Odhiambo. 2007). Some figures estimate annual available freshwater at around 250 m3 per capita in 2025 (Malesu, Oduor & Odhiambo 2007). This would be detrimental to the development of the affected countries. Recent droughts have highlighted the risks to human beings and livestock, which occur when rains fail. Unreliable water supply is one of the biggest threats to the food security of poor small farmers. The vast majority of the rural poor rely on rain-fed land for their survival, making them vulnerable to the highly variable and unpredictable rainfall. Periodic drought and famine are the result, especially in many sub-Saharan African countries (Awulachew, 2009). Despite the dire situation in which farmers find themselves in annually because of seasonal rains, rainwater-harvesting technology for agricultural use has very low adoption rates. In the few cases where it is practiced rainwater is harvested in small quantities to be used for domestic purposes, in addition the quantity collected is not sufficient to last beyond the rainy season. North Nyakach location was randomly selected from the list of ten locations that make up Nyando District in Kenya. This District was purposively selected because it experiences severe floods during the rainy seasons and suffers water crises during the dry season, one wonders why community members have not adopted Rainwater harvesting technology to mitigate against these extremities.

While irrigation may be the most obvious response to drought, it has proved costly and can only benefit a fortunate few. Rainwater harvesting therefore provides a low cost alternative, which if adopted by local communities would significantly improve yields in agricultural activities. The focus of this study therefore is to assess the factors that influence adoption of rainwater systems as a viable source of water for agricultural use among residents of North Nyakach Location, Nyando District in Kenya.

1.3 Statement of the Problem

North Nyakach is an area characterized by episodes of intense rainfall during the long rainy season, which occur between the months of March to May evidenced by incidences of floods experienced during this period (Agricultural Sector Development Strategy, 2010). The subsequent months following the long rains are characterized by severe water scarcity and drought. From practical observation communities seldom harvest this precious resource for agricultural use when rain fails, in the rare cases where they do it is harvested in small quantities to be used for domestic purposes, in addition the quantity collected is not sufficient to last beyond the rainy season. Consequently, the region continues to experience constraints in agricultural productivity, because there is a relatively high risk of crop failure due to increased frequency of dry spells and an uneven rainfall distribution (Agricultural Sector Development Strategy, 2010). In addition the area falls within arid and semi-arid land (ASAL) which can hardly produce through rain-fed without irrigation supplementation (Songa, 2009). According to Songa (2009) Kenya is a food deficit country since consumption requirements exceeds domestic production. The same situation is evident in in North Nyakach Location which is an ASAL and depends on rain fed agriculture for its agricultural production. This study therefore focuses on assessing the factors affecting adoption of rainwater harvesting for agricultural use.

1.4 Research Objectives

To examine the factors that affect adoption of rainwater harvesting technology. Specific objectives of the study were to:

i. Establish the nature of rain water harvesting technologies that are practiced in North Nyakach Location.
ii. Identify the socio-cultural factors influencing utilization of rainwater harvesting technology in North Nyakach Location.
iii. Analyze the challenges facing rainwater harvesting technologies for in North Nyakach Location.

1.5 Research Questions

The study was guided by the following research questions:

i. What is the nature of rainwater harvesting technology in North Nyakach Location?
ii. What are the socio-cultural factors affecting utilization of rainwater harvesting technology in North Nyakach Location?
iii. What are the challenges facing rain water harvesting technologies in North Nyakach Location?

1.6 Research Assumptions

The study was guided by the following assumptions:

i. There is rain water harvesting technology in North Nyakach Location.
ii. There are socio-cultural factors influencing Rainwater harvesting technology in North Nyakach Location.

1.7 Scope and Limitations

While lack of rainwater systems is a problem affecting the whole nation and therefore requires a wide area of coverage, the study area is limited to just one location. Due to financial constraints, the scope of the study area has been significantly reduced.

There is an anticipated challenge of unequal representation of respondents in this study in terms of gender, this is due to the fact that in most rural settings, men move of out of their homes to urban centers seeking employment opportunities while women stay at home to take care of their families, as a result majority of the rural populations are women.

1.8 Justifications

Rain fed agriculture has over the years resulted in poor yields from agricultural activities. This has directly affected food security of rural communities engaged in agriculture as their primary source of livelihood as observed in North Nyakach Location. Furthermore rainwater harvesting technology has proved to be a low cost alternative in providing all year round supply of water to sustain agricultural activities as opposed to irrigation which is expensive and has negative effects to the environment such as water logging of soils and soil salination.

1.9 Definitions of Terms

Patriarchy: A social system in which males are the primary authority figures central to social organization, occupying roles of political leadership, moral authority and control of property. Property and title are inherited by the male lineage.

Land tenure systems: Refers to the political, economic social and legal structure that determines how individuals and groups access and use land and related resources such as trees, minerals, pasture and water. Land tenure rules define how rights to use control and transfer

Mitigation strategy: A plan devised to minimize to the lowest level possible any risks to any project while still managing to maintain optimum output.

Surface run-off: Is the water flow that occurs when the soil is infiltrated to full capacity and excess water from rain flows over the land.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The literature was cited under different themes. These are as follows: history of rain water harvesting technology, nature of rain water harvesting technologies, socio-cultural factors influencing rainwater harvesting systems and challenges facing rain water harvesting systems.

2.2 History of Rain water harvesting Technology

The earliest known evidence of the use of the Rainwater harvesting technology in Africa comes from northern Egypt, where tanks ranging from 200-2000m3 have been used for at least 2000 years – many are still operational today. The technology also has a long history in Asia, where rainwater collection practices have been traced back almost 2000 years in Thailand. The small-scale collection of rainwater from the eaves of roofs or via simple gutters into traditional jars and pots has been practiced in Africa and Asia for thousands of years. (Agarwal and Narain, 1997).

In Western Rajasthan where the Khadin system was used dates back to the 15^{th} century. The khadin system is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production. First designed by the Paliwal Brahmins of Jaisalmer, western Rajasthan in the 15th century, this system has great similarity with the irrigation methods of the people of Ur (present Iraq) around 4500 BC and later of the Nabateans in the Middle East. A similar system is also reported to have been practiced 4,000 years ago in the Negev desert, and in southwestern Colorado 500 years ago. (Agarwal and Narain, 1997).

Stepwell is another example of an indigenous rainwater harvesting system, which were used for utilitarian and as a cool place for social gatherings. When step wells were located outside the village, on trade routes, they were often frequented as resting places. Many important step wells are located on the major military and trade routes from Patan in the north to the sea coast of Saurashtra. When step wells were used exclusively for irrigation, a sluice was constructed at the rim to receive the lifted water and lead it to a trough or pond, from where it ran through a drainage system and was channeled into the fields. These indigenous rainwater-harvesting systems are defunct today (Agarwal and Narain, 1997).

2.3 Nature of Rainwater Harvesting Technologies

In Kenya, there are a myriad of rainwater harvesting schemes implemented in rural areas through different actors; Non-Governmental Organizations and Community effort. In Tseikuru a semi-arid area with water availability and sanitation issues the Kenya Rainwater Association and the German Agro Action have implemented rain water harvesting schemes. Commonly, water is collected by digging shallow holes into dry river beds where groundwater tables are high. These areas are prone to contamination and could be situated many kilometers away, making water collection laborious.

In Lamu, where rainwater catchment has a long history, villagers traditionally use djabias. Djabias are large traditional semi-underground tanks with water harvesting catchment systems that feed into them.

The most commonly used schemes in Kenya are outlined below:

2.3.1 Roof harvesting

The roofs of houses can provide reasonably pure water. However, thatched or lead roofs are not suitable for roof harvesting because of health hazards. A gutter can collect the water and then lead to a down pipe. The roof guttering should slope evenly towards the down pipe, because, if it sags, pools that can provide breeding places for mosquitoes will be formed. During dry periods, dust, dead leaves and bird droppings will often accumulate on the roof; however the first new rains should wash these off. The first water from each shower should be diverted from the clear water container and allowed to run to waste. To further safeguard the quality of the collected rainwater, the roof and guttering should be cleaned regularly. A wire mesh should be placed over the top of the down pipe to prevent it from becoming clogged with washed-off material. A simple sanitary method of collecting rainwater is illustrated in the gutter collects water from the roof and drains into an angled pipe. One piece of the angled pipe leads vertically downward to a small waste drain tank (20 to 25 litres), while the other piece is connected horizontally to a collection tank or reservoir. When rain falls, the first 10 to 15 minutes of rainwater washes off dirt, which might be on the collecting surface and flows into the waste drain tank. After this tank is full, the rest of the rainwater (by this time clean water) flows into the collection tank. The wastewater in the drain tank should be emptied before the next rainfall. (Awulachew, Lemperirere and Tulu 2009).

2.3.2 Water pans/earth dams

These are large water storage structures of around 20,000m3 with a filter and separate watering points for livestock and domestic use. Both are excavated on the goring mostly using machines, but can also be excavated manually. A fence is put round the pan/dam to prevent contamination. Auxiliary structures are also constructed, such as community water points; cattle troughs; and gender-sensitive latrines – this also prevents contamination by encouraging specific uses for the different structures.

2.3.3 Farm ponds

Farm ponds are used for agricultural purposes, including drip irrigation. They are hand-dug to 50m3 in capacity and are lined and roofed to prevent seepage and evaporation. A simple settling basin (silt trap) is included to ensure that only clean runoff water enters the pond. Guttering is also added on the roof to collect water. In order to use pond water efficiently, low-head drip kits are installed. These are low-cost and therefore affordable for the farmers.

2.3.4 Rock catchments

Rock catchments collect water through a masonry guttering system on a sloping rock-face that directs water into storage tanks for domestic use and into drinking troughs for livestock. GHARP/KRA is currently implementing rock catchment projects in Mwingi and Kyuso districts of Kenya. The structural components for rock catchments include gutters, weirs, pipes, reservoirs, and usually tanks.

2.3.5 Sand and sub-surface dams, and shallow wells

Sand and sub-surface dams are constructed in sandy river beds where the trapped sand acts as a storage reservoir. Water abstraction is from shallow wells located upstream of the dam wall and the water can be used for livestock, domestic, and agricultural uses. A shallow well is dug beside the dam on the upstream. Most of these shallow wells are lined to control collapsing, and are installed with hand pumps. With the implementation of the RWH structures mentioned above, farmers are able to access water easily for productive purposes. Even when there is drought, water which has been stored during the rainy season can then be used during the dry periods for irrigating crops and for livestock drinking water. A sustainable source of water means sustainable production - a pre-requisite for farmers who want to progress along the APVC.

In North Nyakach Location roofs are the most popular catchments of water for domestic water. The impermeable roofs yield high runoff of good quality water that is used for all household purposes. The roofs are made of iron sheets and these could either be painted or galvanized.

2.3.6 Runoff harvesting

Runoff harvesting can be done over the short or long term. The short-term purpose for runoff harvesting can be for small-scale water use. The long-term runoff harvesting is mainly done for building a big water stock for the purpose of irrigation, livestock or fisheries. Either constructing reservoirs or big-sized ponds are methods of long-term runoff harvesting.

Short-term runoff harvesting techniques

ainwater can be collected from the ground surface (Figure 4). As it rains, part of the water will wet the ground and be stored in depressions, or lost through evaporation or infiltration. A considerable reduction of such water losses can be given by laying tiles, concrete, asphalt or plastic sheeting to form a smooth impervious surface on the ground surface. Another method involves the chemical treatment of the soil. Also occasionally, simply compacting of the surface of the ground is adequate.

Long-term runoff harvesting techniques

The most common long-term runoff harvesting structures are dugout ponds and embankment type reservoirs. Dugout ponds are constructed by excavating the soil from the ground surface. Groundwater, or surface runoff or both may feed into these ponds. Construction of these ponds is limited to those areas, which have land slope of less than 4% and where water table lies within 1.5 to 2.0 meters depth from the ground surface. Dugout ponds involve more construction costs and therefore are generally recommended when embankment type ponds are not economically feasible for construction. The embankment dam is constructed by damming across a valley or depression of a watershed. The storage capacity of the reservoir is determined on the basis of water requirement for various demands and available surface runoff from the watershed. Embankment type reservoirs are again classified according to the purpose for which they are meant, namely: irrigation dams, silt detention dams, farm ponds, water harvesting ponds, and percolation dams.

2.4 Social-cultural factors influencing Rainwater Harvesting

2.4.1 Tenure systems for Rainwater harvesting technology.

It is becoming more widely accepted that unless people are actively involved in the development projects which are aimed to help them, the projects are doomed to failure. It is important that the beneficiaries participate in every stage of the project. When the project is being planned, the people should be consulted, and their priorities and needs assessed. During the construction phase the people again should be involved -supplying labour but also helping with field layouts after being trained with simple surveying instruments (Ellis-Jones & Tengberg, 2000:20).Throughout the course of the season it is helpful to involve people in monitoring, such as rainfall and runoff and recording tree mortality. A further participatory role is in maintenance, which should not be supported by incentives. After the first season it is the farmers themselves who will often have the best ideas of modifications that could be made to the systems. In this way they are involved in evaluation, and in the evolution of the water harvesting systems (Ellis-Jones & Tengberg, 2000:20)

Land tenure issues can have a variety of influences on water harvesting projects. On one hand it may be that lack of tenure means that people are reluctant to invest in water harvesting structures on land which they do not formally own. Where land ownership and rights of use are complex it may be difficult to persuade the cultivator to improve land that someone else may use later. On the other hand there are examples of situations where the opposite is the case - in some areas farmers like to construct bunds because it implies a more definite right of ownership. The most difficult situation is that of common land, particularly where no well-defined management tradition exists (Ellis-Jones & Tengberg, 2000:20). According to Dreschel et al (2005) farmers hesitate to invest time and money in setting rainwater harvesting structures because they lack security on land ownership and have limited access to local markets for their surplus crops. Farmers especially those with least resources usually expect to see benefits with a cropping season from such technological investment. In the case of soil and water conservation measures (In Situ rainwater harvesting structures) it usually involves significant initial and on-going investment in both cash and labour with benefits being realized in the long term.

In North Nyakach like most parts of the country the ownership of rainwater systems is attached to individual household owners. Traditionally, the rights of ownership, access and management of household resources are bequeathed to individual household heads. The ownership, access and management rights for water tanks are therefore vested with the household heads which in the patriarchal society that North Nyakach is means ownership is vested in Men. Women manage the facilities with the children as part time operators yet women are the major contributors to the development and sustenance of individual households. Women and children are the key beneficiaries, with most tanks built through the merry-go-round schemes involving women groups. The construction of tanks in schools eases the burden of fetching water on children.

2.4.2 User behavior patterns with domestic RWH

Rainwater that has been harvested is used in many different ways. In some parts of the world, it is used merely to capture enough water during a storm to save a trip or two to the main water source. Here, only small storage capacity is required, maybe just a few small pots to store enough water for a day or half a day. At the other end of the spectrum, in arid areas of the world, systems which have sufficient collection surface area and storage capacity to provide enough water to meet the full needs of the user. Between these two extremes exists a wide variety of different user patterns or regimes.

In North Nyakach so far, the initiated rainwater harvesting projects are small scale to be used for domestic purposes, with exceptions of a few water projects in the form of Water pans and small-scale dams. Even in these instances the collected water is specifically for domestic use i.e. drinking, cooking, washing. There is little experience with rainwater harvesting for agricultural use.

2.4.3 Capacity to implement Rainwater Harvesting Technology

Although many organizations are involved in water-related activities, the capacity of the community and government is still inadequate to take advantage of the potential that rainwater harvesting offers in mitigating the effects of water scarcity in most parts of Kenya. To date there has been little funding for water assistance projects and much of the clean water that falls out of the sky has been left unharnessed (Amsha Africa foundation, 2010). Nevertheless rainwater harvesting is mostly practiced by NGOs and UN agencies show-casing or proving to governments and key donors that the technology is a viable investment. Even in such instances the projects initiated target rainwater for domestic use, very little is said about rain water harvesting for agricultural use. So far, information on costs and benefits is insufficient for econometricians to use in assessing the viability of RWH.

Rainwater harvesting is not adequately mainstreamed in policy documents, the current Water policy in Kenya does not address rainwater harvesting as a viable source of water for agriculture as a result RWH has often been overlooked by planners, engineers and builders. The reason that RWH is rarely considered is often due to lack of information – both technical and otherwise. Rainwater harvesting are simple, low-cost techniques that involve the capture and storing of rainwater and/or groundwater. Such systems have been used all over the world for long time periods and go under different names such as small-scale water system innovations and rainwater catchment systems.(Amsha Africa Foundation, 2010)

2.4.4 Types of existing rooftops

The catchment of a water harvesting system is the surface that receives rainfall directly and drains the water to the system mostly practiced is on rooftop RWH, but surface run-off RWH is also possible. Surface water is, however, in most cases not suitable for drinking purposes since the water quality is not good enough, however it is appropriate for agricultural use. Any roofing material is acceptable for collecting water. However, water to be used for drinking should not be collected from thatched roofs or roofs covered with asphalt. In addition, lead should not be used in these systems. Galvanized, corrugated iron sheets, corrugated plastic and tiles make good roof catchment surfaces. Flat cement or felt-covered roof can also be used provided they are clean. Undamaged asbestos cement sheets do not have a negative effect on the water quality. Small damages may, however, cause health problems. (Worm and Hattum, 2006) In rural Kenya however housing is based on the original African architecture of grass, cow dung and mud houses which do not provide adequate catchment surface for rainwater harvesting. There are exceptions in some households that have built houses with corrugated iron sheet roofs but these either do not practice rainwater harvesting and where they do, it is in small scale to be used for domestic purposes i.e. drinking, cooking, and washing.

2.5 Challenges facing rainwater Harvesting Systems

Sustainability of most of Rain Water Harvesting Systems after the donor withdrawal has been found wanting and unmanageable by the beneficiaries particularly in the rural parts of Kenya. In spite of the great efforts in the area of water resources development, with the construction of large water projects, there is still under-provision of water for domestic use particularly in the rural and slum areas of Kenya, as more than 67% of rural household still have no access to clean and safe drinking water. The problems of irregular water supply due to poor maintenance, lack of funds, broken facilities and rapid population increase, among other factors, have now reached a critical state. (Aroka, 2010)

2.5.1 Financial constraints

Financial circumstances may influence the design of a RWH structure. However, one should realize that financial reasons can hardly be a restriction for building a rainwater catchment system. Run-off from a roof can be directed with little more than a split pipe or piece of bamboo into an old oil drum (provided that it is clean) placed near the roof. More advanced designs signs include the use of aluminum pipes and reinforced cement Tank with a first flush, overflow tap and a water quality filter. Between those extremes, there are many different suitable options and techniques. (Worm and Hattum, 2006)

Almost every house or building has a suitable catchment area or roof, but the guttering and the water storage do require some investments. The water storage tank or reservoir usually represents the biggest capital investment element of a rainwater harvesting system and therefore requires careful design to provide optimal storage capacity while keeping the cost as low as possible. Installing a water harvesting system at household level can cost anywhere from USD100 to 1,000. It is difficult to make an exact estimate of cost because it varies widely depending on the availability of existing structures, like rooftop surface, pipes and tanks and other materials that can be modified for a water harvesting structure. Additionally, the cost estimate mentioned above is for an existing building and the actual cost depends on the final design and size of the tank, and the availability and price of these items. The cost would be comparatively less if the system were incorporated during the construction of the building itself. Therefore rainwater harvesting is particularly recommended for reconstruction operations after natural disasters (such as the tsunami in Asia) or wars. (Worm and Hattum, 2006)

2.5.2. Policy Issues

In many instances community based organisations, non-governmental organizations, government departments and even some donor agencies lack policy guidelines in support of rainwater harvesting. Those that have are generally inadequate, and unsuitable to the prevailing local conditions. For example the Ministry of Water resources in Kenya have no mechanism of approving the construction of a Ferro-cement tank or water jar since they do not have design standard drawings. The city council by-laws only allow for effective disposal of rainwater from roofs to avoid dumpiness and drainage problems but not to collect for beneficial purposes. Thus, most of the rainwater harvesting projects, particularly in Central, Eastern, Coast and Nyanza regions evaluated are faced with some of the following challenges: (Wanyonyi, 2009)

Inadequate legal advice in projects formation and outlined objectives as per relevant constitutional framework, Limited policies and by laws in funds and fundraising strategies to allow for effective project implementation and management, Lack of collaboration and networking amongst stakeholders, Limited community mobilisation policy for water related activities, Low rate of community participation and contribution to project development, Inadequate water quality improvement structures, control and usage, Limited training and technological transfer in rainwater harvesting at project level, Lack of operation and maintenance guidelines for rainwater infrastructure such as gutters, tanks catchments and fittings.

2.5.3 Technical Issues

No matter how well designed a rainwater harvesting system, if it is not technically efficient, it will not deliver or perform the anticipated functions. Many projects, particularly in the rural areas, are not sustainable or cannot be replicable due to inadequate technical interventions, e.g. construction of roof catchment system, shallow wells, tanks and VIP latrines requires detailed technical instruction for effective implementation. The absence of such technical instructions at project level implies inadequate technological transfer and poor project management resulting in a high failure rate.

A 1998 survey by KRA of 16 community based water projects indicated that lack of technical interventions is the major cause of project failures. Assessment of the infrastructure shows that the communities were not fully involved in the planning and technology selection. The method of fixing gutters, taps, tank construction valves and operation and maintenance guidelines are not fully understood nor issued to the community on the commissioning of the project.

Technology selection by a ccommunity means acceptance, implying an understanding and willingness to be associated with it, irrespective of some shortcomings in community participation. Technical challenges facing many local initiatives in rainwater harvesting projects particularly were identified as follows: (Wanyonyi, 2009)

Inadequate construction guidelines for tanks, gutters, filters, Inadequate technologicall transfer to the beneficiaries, Lack of suitable training programmes in rainwater harvesting; Poor technical selection and usage of local materials, Sizing of storage tanks, with respect to rainfall data and costs, Lack of water quality improvement structures and control, Inappropriate guttering system in design, construction (support) and maintenance.

Technological challenges in rainwater harvesting could be turned into realities by adopting pragmatic approaches like creating awareness through exposure (CATE), involving other stakeholders, use of appropriate designs in the rainfall data, guttering systems, and sizing of storage tanks and use of locally available resources. (KRA Report 1999). If rainwater harvesting were considered a supplementary source of water supply in small urban centre and arid and semi-arid lands (ASALs) of Kenya, then accessibility and coverage of safe drinking water would increase to over 74%. Presently it is estimated that only 32.5% of households in rural parts and 93.3% in urban centres of Kenya have access to safe drinking water. But accessibility does not in any way mean availability and reliability, (CBS 1994).

2.5.4 Managerial Issues

Compared to the existing piped water supply in most in those districts, household community-based water supplies are much more efficient than centrally controlled large piped water schemes. There is a sense of ownership, community participation and contribution in the management of community based water projects unlike in the government projects where the water managers have little or no enthusiasm in the management affairs. The managerial issues of major concerns that were raised included among others: (Wanyonyi, 2009)

Limited use of local resources, inadequate community participation and contribution – due to approaches, inadequate project management skills, by community organisation; Poor financial management and bookkeeping resulting in financial loss, Lack of proper water usage and control measures, Lack of awareness and unwillingness to obtaining legal status due to taxation, Donor dependency syndrome, and Political interference within the community projects.

Experience in low-income housing areas show that it is relatively easy to arouse people's interest in rainwater tank construction; since they are perceived as desired improvements to their homesteads and a symbol of status particularly in the rural areas.

The large government owned water projects have a high potential in overcoming managerial challenges of low cost community based water projects. Legally formulated by-laws and registration of self -help water projects, improvement of financial and management skills through local training will enhance effective and proper water usage and control.

The essence of appropriate technology is that equipment and techniques selected particularly in RWH should be relevant to local resources and needs, feasible to organise and suitable for the local environment and above all more efficient than the one existing.

2.6 Theoretical Framework

The Innovation Decision Process Theory is one of the adoption diffusion theories presented by Rogers in 1995. Innovation diffusion uses an approach in which the decision to adopt new technology is mainly based on perceptions of the technology within the decision-making unit (Rogers 1995; Tatnall & Burgess 2004). According to this theory, potential adopters of an innovation progress overtime through five stages namely knowledge, persuasion, decision, implementation and confirmation or reaffirmation. In this study, the innovation is the adoption of rainwater harvesting technology and the adopters are the household members. The Innovation Decision Process Theory is applied as follows.

First with regard to knowledge, the household members are supposed be knowledgeable about the rainwater harvesting technology. This calls for proper training on the subject. Secondly, with regard to persuasion the household members are supposed to be convinced that adoption of rainwater harvesting technology is important. After realizing the importance of adopting rainwater harvesting technology, the household members would then be in a position to make a decision to implement the rainwater harvesting systems. This calls for support from the change agents for example the government or Non-governmental organisations, in terms of provision of the required resources. Then finally, there should be the Confirmation stage where adoption of rainwater harvesting technology is justified or rejected based on the evidence of benefits or drawbacks.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

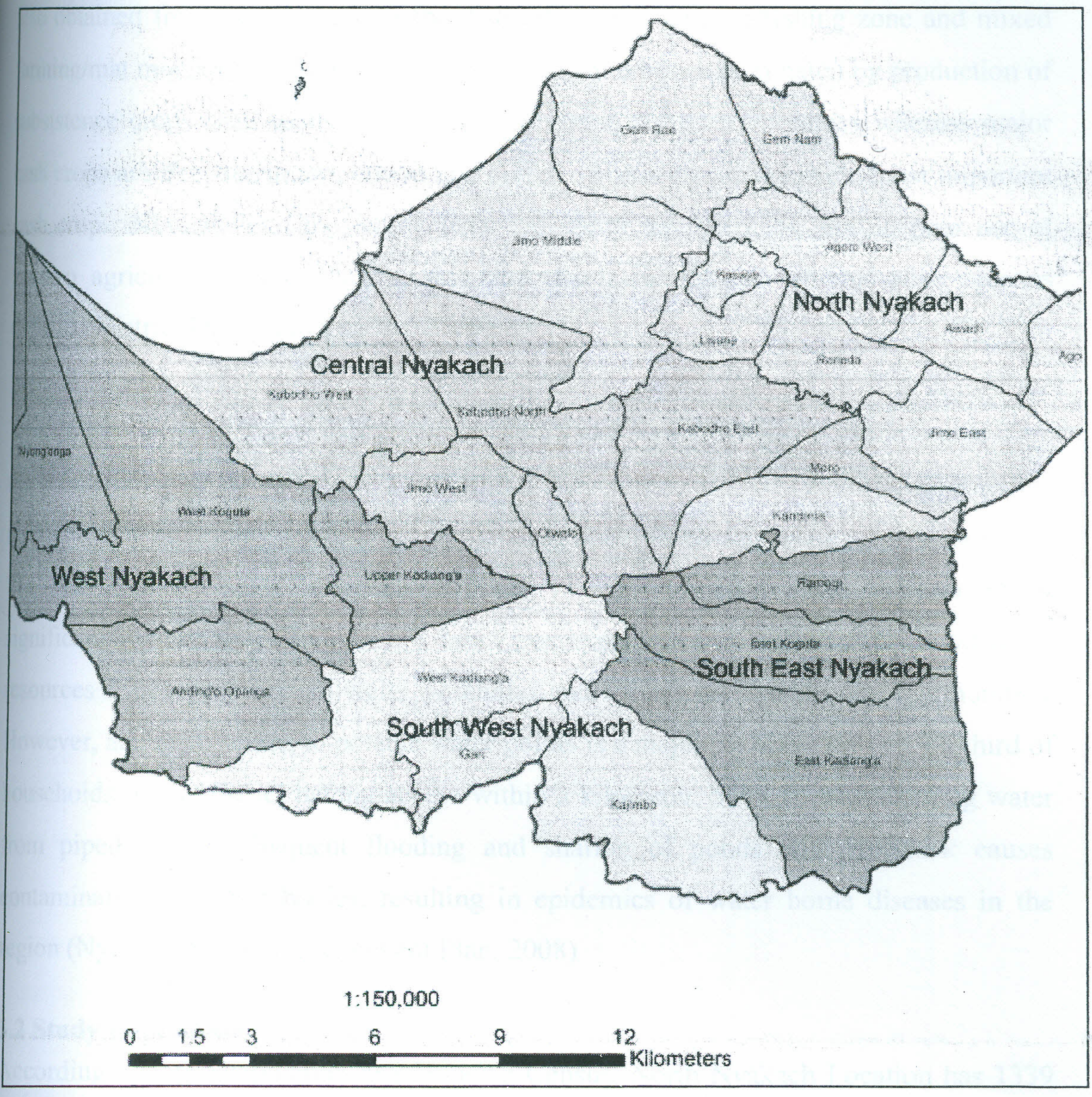
This section contains the study area, study population, study design, unit of analysis, sampling procedure, data collection and data analysis.

3.2 Study Area

This study will be carried out in North Nyakach Location in Nyando district. Nyando is among the twelve districts that make up the Nyanza province. It has a geographical coverage of 1,168.4 km2 and is divided into five administrative divisions: Upper Nyakach, Lower Nyakach, Nyando, Miwani and Muhoroni. The district lies in the eastern part of large lowland surrounding the Nyanza Gulf, much of it being in Kano Plains. The topography can be generally classified into three land formations: the Nandi Hills, the Nyabondo Plateau, and the Kano Plains. The Kano Plains comprise of predominantly black cotton clay soils with moderate fertility and poor drainage. The rest of the district has sandy clay loam soils derived from igneous rocks.

Altitude rises from 1,100m along the Kano Plain to 1,800m above sea level in Nyabondo Plateau. Mean annual precipitation lies between 600-1,630mm. However, the rains are bimodal and exhibit wide variation in distribution. The district has only one gazetted forest, Koguta, covering a mere 3.2 km2. There is a small shoreline (11 kms) to the southwest bordering Lake Victoria, where several beaches are found and fishing carried out. The soils and climatic conditions of the district are ideal for sugarcane cultivation especially in Muhoroni, Miwani and parts of Nyando division while the swampy areas along river Awach and Nyando are appropriate for rice growing. The Kano Plain with its black cotton soils is most suited for cotton production. The relatively high areas of Nandi Hills and Nyabondo Plateau provide a good environment for dairy and coffee production. Nyando district is prone to flooding especially in Kano Plains and water overflow that has caused extensive erosion in Lower Nyakach and Miwani divisions resulting in huge gulleys such as Katuk Ondejo in Lower Nyakach. Most of the hilltops in the region are bare and forest excision for charcoal burning is extensive. (Nyando District Development Plan 2008).

Figure 1.0 Map of Nyakach constituency is shown below.



Source: Nyando District Development Plan 2008

Nyando district is a food deficit zone despite being considered 99% cultivable. This is partly due to unreliable rainfall. The district produced 33,892 MT of cereals in 2005 as compared to its annual cereal demand of 51,465 MT. This means own production can only take the district for seven months and hence the reliance on inter district trade with neighboring high potential districts of Nandi, Trans Nzoia and other districts to meet the deficit. For the households in the district, this means reliance on the markets for a significant share of food eaten. Over 60% of cereals consumed at household level are sourced from markets. Similarly, about 64% of beans consumed by the households are also obtained from the markets, in the district's mixed farming/fishing zone and mixed farming/mat making livelihood zones. Cropping patterns are dominated by production of subsistence crops such as maize, cassava, sorghum and sweet potatoes whereas major cash crops are rice, sugarcane, cotton and coffee. Sugarcane ranks as the most important cash crop. Nevertheless, the output from the sector has been low due to poor use of modern agricultural technology, erratic and unreliable rainfall, among other reasons (Nyando District Development Plan, 2008).

Nyando has two main rivers namely Sondu Miriu and Nyando. River Nyando drains from the Nandi hills, where relatively high rainfall is received, to Lake Victoria, through the through the Kano Plains where it causes flooding along its banks during rainy season.

The district has a small shoreline of about 11 kms bordering Lake Victoria. Other significant surface water sources are dams, ponds and streams. The underground water resources are fair and several wells, boreholes and springs are used by the communities. However, adequate access to potable water points is a major problem with only a third of households in the district having access within a kilometer, 50% of them drawing water from piped outlets. Frequent flooding and sharing of ponds with livestock causes contamination of water bodies, resulting in epidemics of water borne diseases in the region (Nyando District Development Plan, 2008)

3.2 Study Population

According to 2009 Population and Housing Census, North Nyakach Location has 1339 households. The Location has two sub locations that are Gem Nam and Gem Rae, with a population of 6205 people. The number of females is higher than that of men in the location at 3228, while men are 2977. The area has a population density of 259.6 persons per square Kilometer.

3.2 Study Design

The research design to be used in this study is survey research design. The study aims at collecting information from respondents on whether or not they have adopted rainwater harvesting technology for agricultural use, and their reasons for adoption or not.

3.3 Instruments of Data collection

The tool that will be used to collect data is questionnaires administered to the sampled population. The researcher will use both primary and secondary data. Primary data will be obtained using questionnaires while secondary data will be obtained from internet, journals, and books.

3.4 Unit of Analysis

The unit of analysis will be a household in North Nyakach Location.

3.4.1 Sampling Procedure

Purposive sampling has been used to select North Nyakach as the study area because it is amongst the worst hit areas by flooding during the long rains. In this sample method, the researcher purposely targets a group of people believed to be reliable for the study (Kombo and Tromp, 2006).

3.4.2 Sample size

The Cochran's (1963) sample formula was used to arrive at the sample size as shown below.

Equation 3.1

Assumptions

Alpha level is 0.05

Acceptable margin of error 0.03

$$\underline{no} = \frac{(\underline{t})^2 * (\underline{s})^2}{(\underline{d})^2} = \frac{(1.96)^2(1.167)^2}{(7*0.03)^2} = 118$$

(3.1)

Where $\underline{no}$ = required return sample size

$\underline{t}$ = Value for selected alpha level of 0.025 in each tail = 1.96 (The alpha level of 0.05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error).

$\underline{s}$ = Estimate of standard deviation in the population = 1.167 (Estimate of variance deviation for 7 point scale calculated by using 7 [inclusive range of scale] divide by 6 [number of standard deviations that include almost all (approximately 98%) of the possible values in the range]).

$\underline{d}$ = Acceptable margin of error for mean being estimated = 0.21 (number of points on primary scale multiply by acceptable margin of error).

However, since sample size (118) exceeds 5% of the number of households in the Division, Cochran's (1977) correctional formula was used to calculate the final sample size for the number of households as shown in equation (3.2)

Equation 3.2

$$\underline{n} = \frac{no}{1 + {no}/{pop}} \qquad (3.2)$$

Where pop = population of (Total number of households in the Location)

$\underline{no}$ = Required return sample size according to Cochran's formula =118.

$\underline{n}$ = required return sample size because sample > 5% of population (Cochran, 1977).

The total sample size required is 108.

3.5 Data Collection

The study will employ both qualitative and quantitative data. Quantitative data will be collected using structured questionnaire that will be duly tested and thoroughly improved. In addition, a Likert type attitude scale of 1-5 will be developed to assess the underlying attitude of the community on rainwater harvesting technology.

Secondary data will be collected from relevant sources, such as reports, socioeconomic survey documents of the area, maps, books and Non-Governmental Organizations (NGO).

3.6 Data Analysis

Data was analyzed using descriptive statistics. Qualitative data was used to specify contexts of the study and enrich information generated from quantitative data analysis. The data was analysed using the Statistical Package for Social Science (SPSS).

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND DISCUSSION.

4.1 Introduction

This section contains data analysis and discussion of the findings illustrated in frequency tables.

4.2 Nature of rainwater harvesting technologies

108 respondents were sampled for this study. In terms of adoption of Rain water harvesting Technologies the results were as follows:

Table 4.1 Percentage of Community members practicing rain water harvesting

Rainwater Harvesting practice		
Response	**Frequency**	**Percentage**
Yes	51	47.6
No	57	52.4
Total	108	100.0

(Source, Researcher 2013)

The results indicate that 47.6% of the sampled respondents practice rainwater harvesting while 52.4% do not practice rainwater harvesting, in other words majority of community members in North Nyakach location have not adopted rain water harvesting technology.

Table 4.2 Alternative Water sources for community members

Water source	Frequency	Percent	Cumulative percent
River/stream	48	94.8	94.8
Borehole	2	3.9	97.4
Dam	1	1.3	100.0
Total	51	100.0	100.0

(Source, Researcher 2013)

Out of the community members who do not practice rainwater harvesting 94.8% draw their water from rivers or streams while 2.6% get water from boreholes and the remaining 2.6% get water from a dam. The major alternative water for community members is rivers or streams.

Table 4.3 System Installed

Gutter system	Frequency	Percent	Cumulative percent
Gutters directed To underground tank	5	10.5	10.5
Gutters directed to Upper tank	30	57.9	68.4
Ground catchment Water tanks	3	5.3	73.7
Roof catchment Directed to jerricans	13	26.3	100.0
Total	53	100.0	100.0

(Source, Researcher 2013)

Table 4.3 shows the rainwater harvesting systems that have been installed by community members, 57.9%have installed roof gutters and upper tanks, 10.5% have roof gutter and underground tank, and 26.3% have roof gutter with water directed to jerricans while the remaining 5.3% have not installed ground catchment water pans. The figures indicate that roof gutters and upper tanks is the most common type of system adopted by community members. This system is mostly adopted because it is simple and is not capital intensive as opposed to water pans. The harvested water is limited by the size of the upper-tank, the smaller the lesser the amount of collected water.

Table 4.4 Purpose for which harvested water is used for

Purpose	Frequency	Valid percent	Cumulative percent
Drinking, cooking, Washing	46	89.5	89.5
Watering vegetables	5	10.5	100.0
Total	51	100.0	

(Source, Researcher 2013)

Table 4.4 shows the results for which the collected rain water is used. 89.5% use the water strictly for drinking, 10.5% use the water for watering vegetables. Majority of community members use the collected rain water for domestic uses. This scenario is most likely because the amount of water collected is little and would not be sufficient for activities such as irrigation.

Table 4.5 Duration which the collected water lasts

Months	Frequency	valid percent	Cumulative percent
1-2	40	78.9	78.9
2-4	8	15.8	94.7
4-6	3	5.3	100.0
Total	51	100.0	100.0

(Source, Researcher 2013)

Table 4.5 shows the duration which the collected water lasts 78.9% of the respondents use their water for 1-2 months, 15.8% use it for 2-4 months while 5.3% of the respondents use it for 4-6 months. Majority of the respondents use their water for a relatively short time because the quantity of collected water is little and cannot therefore be used for longer periods. Community members have not invested in large storage equipment due to lack of funds and know-how on what materials are appropriate for harvesting rain water.

4.3 Socio- cultural factors affecting Rain Water Harvesting Technology in North Nyakach.

Table 4.6 Role in the household

Father	Frequency	Percent	Cumulative percent
Father	46	42.9	42.9
Mother/wife	52	47.6	90.5
Son	10	9.5	9.5
Total	108	100.0	100.0

(Source, Researcher 2013)

In terms of roles in the household the respondents were represented as follows;

Father 42.9%, Mother/ Wife 47.6% and Sons 9.5%. There is an average representation of both Fathers and mothers with mothers leading with a small margin of 5%. Sons are the least represented at 9.5 %.

Table 4.7 Existing water sources in the community

Response	Frequency	Valid percent	Cumulative percent
Yes	46	56.3	56.3
No	36	43.8	100.0
Total	82	100.0	100.0

(Source, Researcher 2013)

Table 4.7 indicates the level of awareness on existing rain water harvesting systems among community members. 56.3% are aware of Rain Water Harvesting Systems while 43.8% do not know if Rain Water Harvesting Technology exists within the community. This indicates an average level of awareness on rainwater harvesting technology. This scenario is most likely because there have been no sensitization programs on rain water harvesting technology, the few community members who have adopted the technology are innovators who observed the technology from other regions.

Table 4.8 Roofing type

Roof type	Frequency	Valid percent	Cumulative percent
Grass thatched	5	4.8	4.8
Iron sheets	95	88.1	92.1
Tiles	8	7.1	100.0
Total	108	100.0	100.0

(Source, Researcher 2013)

The community members had the following roof types; Iron sheets 88.1%, Tiles 7.1% and grass thatched roofs trailing at 4.8%. Iron sheets are the major option in terms of roofing type. This is the ideal catchment surface for Rain Water Harvesting.

Table 4.9 Decision to construct house with mentioned roof type

Role	Frequency	Valid percent	Cumulative percent
Father	77	71.4	71.4
Mother	21	19.1	90.5
Son	10	9.5	100.0
Total	108	100.0	100.0

(Source, Researcher 2013)

Table 4.9 shows results indicating whose decision it was to construct the house with the roof type mentioned; Father/Husband 71.4%, mothers/wife 29.1% and Son 9.5%. Fathers or husband are the main decision makers in the households, followed by mothers and finally sons. These findings reflect the patriarchal set-up that community members in North Nyakach location live in, decisions are solely made by men who are the heads of households.

Table 5.0 on whose land the RWS been built

Role	Frequency	Percent	Cumulative percent
Father	108	100	100
Mother	0	0	100
Son	0	0	100
Total	108	100	100

(Source, Researcher 2013)

Table 5.0 indicates that all the land on which the rain water harvesting systems have been built are owned by Fathers/Husbands. Wives and Sons do not own any of the land. Land tenure systems in North Nyakach location are influenced by patriarchy, where the men who head households own the land; women can use the land but do not own any.

Table 5.1 Decision to install rainwater harvesting system

Role	Frequency	Percent	Cumulative percent
Father	27	52.6	52.6
Mother	11	21.1	73.7
Son	13	26.3	100.0
Total	51	100.0	100.0

(Source, Researcher 2013)

Table 5.1 indicates the decisions to install rainwater harvesting system 52.6% of the respondents are fathers, 21.1% are mothers and 26.3% are sons. Traditionally, the rights of ownership, access and management of household resources are bequeathed to individual household heads. The ownership, access and management rights for rain water harvesting systems are therefore vested with the household heads which in the patriarchal society that North Nyakach is means ownership is vested in Men.

Table 5.2 Opinion on the Importance of Rain water Harvesting Systems

Response	Frequency	percent	Cumulative percent
Not important	3	2.4	2.4
Important	39	35.7	38.1
Extremely important	66	61.9	100.0
Total	108	100.0	100.0

(Source, Researcher 2013)

Table 5.2 indicates the opinion of community members on the importance of rainwater harvesting systems. 61.9% feel that RWHS are extremely Important, 35.7% feel RWHS are Important while 2.4% feel RWHS are not important. Generally community members admit that the technology is vital for their daily activities probably because they have observed this from the members who have already adopted the systems and are enjoying its benefits.

4.4 Challenges facing Rain Water Harvesting Technology in North Nyakach Location.

Table 5.3 Challenges facing RWHS

Response	Frequency	Valid percent	Cumulative
Yes	108	100.0	100.0
Total	108	100.0	100.0

(Source, Researcher 2013)

Table 5.3 indicates the results for opinions of community members with regard to challenges facing RWHS, 100% of the sampled community members admit to facing challenges in the adoption and implementation of RWHS.

Table 5.4 Challenges facing adoption and Implementation of RWHT

Challenges	Frequency	percent	Cumulative percent
Lack of funds to install System	77	71.4	71.4
Maintenance of systems is Expensive	26	23.8	95.2
Storage materials are not Enough	5	4.8	100.0
Total	108	100.0	100.0

(Source, Researcher 2013)

Table 5.4 shows results indicating the type of challenge faced by community members. 71.4% mention lack of funds to install rain water harvesting systems, 23.8% say maintenance of systems is expensive and 4.8% say storage materials are not enough. Lack of funds to install RWHS is the main reason for the low adoption of the technology. This scenario reflects the level of awareness with regard to rain water harvesting technology because there are simple systems that community members can adopt which are not capital intensive such as the djabias in Lamu, where rainwater catchment has a long history. Djabias are large traditional semi-underground tanks with water harvesting catchment systems made out of bamboo that feed into them.

Table 5.5 Challenges facing Rainwater Harvesting Technology.

Challenges	**Frequency**	**percent**	**Cumulative percent**
Insecurity-theft of tanks and gutters	21	32	32
Treatment of water is Expensive	5	8	40
Wind destroys installed Systems	34	52	92
Rain patterns not Reliable	5	8	100
Total	65	100.0	100.0

(Source, Researcher 2013)

Table 5.5 further indicates challenges experienced by community members. 32% mention insecurity or theft of tank and gutters, 8% say treatment of water is expensive, 52% say wind destroys installed systems while 8% say rain patterns are not reliable. Wind destruction is the second most significant reason for the low adoption of rain water harvesting technology.

Table 5.6 Challenges facing Rainwater harvesting technology

Challenges	Frequency	percent	Cumulative percent
Cleaning of tank is difficult and expensive	36	66.7	66.7
Impractical to install on a grass-thatched roof	12	22.2	88.9
Catchment surface is small	6	11.1	100.0
Total	54	100.0	100.0

(Source, Researcher 2013)

Table 5.6 shows results for challenges as follows; 66.7% mention cleaning of tanks as being expensive and difficult, 22.2% say it's impractical to install systems on a grass thatched roof and 11.1% say catchment surface is small. The expense involved in cleaning of tanks is the third most significant challenge faced by communities in North Nyakach location.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECCOMENDATION

5.1 Introduction

This section contains the conclusion and the recommendations of the study.

5.2 Summary

A majority of residents in Lower Nyakach division have not adopted Rain Water Harvesting Technology as shown in table 4.1; they draw their water from rivers and streams. The same majority are aware of RWHT but quote challenges preventing them from adopting the technology. Gutters directed to upper tanks form the most popular system by "users" of the technology while ground catchment e.g. water pans are the least used systems. Further table 4.4 shows the purpose for which collected water is intended; the harvested water is mainly used for drinking, washing and cooking while agricultural activities form a very small percentage of use of harvested rain water. The harvested rain water does not last beyond 2 months both during the long rains and short rains as shown in table 4.5. Of the sampled respondents fathers and mothers form the majority of the participants in this survey.

In terms of roofing type iron sheets are the most popular roofing material adopted by 95% of the sampled community members as shown in table 4.8, it is the ideal catchment surface for rain water harvesting. Fathers are the major decision makers in terms of choosing which material to use for house construction and the decision to install RWHS, this is shown in table 4.9 with a majority of 77% , the land on which the systems are installed belong primarily to the fathers as shown in table 5.0 with a majority of 100%. Women and children are the major beneficiaries of water and bear the brunt of searching for water during droughts yet they do not make any decisions with regard to whether or not to install Rain Water Harvesting Systems or which roofing material to use, neither do they own land.

The level of awareness with regard to Rain Water Harvesting Technology is average as shown in table 4.7 where 56.3% of the respondents are aware about rain water harvesting technology and its existence within the location, but community members cite challenges preventing them from adopting the technology with the following challenges featuring as the most common: lack of funds to install systems as shown in table 5.5, wind destroying the installed systems illustrated in table 5.6, and the difficulty and expense involved in cleaning of tanks illustrated in table 5.7.

5.3 Conclusions

The study borrowed from the theory Adoption Innovation Theory to explain the factors influencing the adoption of Rain Water Harvesting Technology. The findings of the study agree with the theory. The five stages in the Adoption and Innovation theory were considered. First with regard to knowledge most of the community members had not been trained and were therefore not knowledgeable about Rain Water Harvesting Technology. With regard to persuasion most community members were not convinced that the installing Rain Water harvesting Systems for agricultural use was necessary. In most cases the third stage (implementation) could not take place because there was lack of support in terms of providing training materials and resources. Likewise the confirmation stage could not take place, an indication that the Rain Water Harvesting Technology has not been well adopted.

Rain Water Harvesting Technology is the best initiative to address the challenges faced by Rain fed agriculture. However the full potential in implementing these systems has not been realized due to several factors. The study has established that community members are unable to access the resources required to implement these systems, they have very little knowledge with regard to the technology. Furthermore very little effort was put to create a supportive environment for Implementing Rain water harvesting systems. In addition, there was no system for monitoring and evaluating the process.

Lastly the study concludes that adoption of Rainwater harvesting technology has not been successful because women and children who bear the brunt of water scarcity are not involved in decision making, they do not own land and cannot therefore own the few Rain water harvesting systems that have been implemented.

5.4 Recommendations

Based on the findings of this study, the researcher recommends the following;

Community members need to be sensitised on the cheaper Rain Water Harvesting Systems that they can adopt to make use of this precious resource e.g. use of bamboo stems as gutters and directing water to shallow wells. Installing cheaper systems is important so as to mitigate the high costs involved in purchasing upper tanks and modern guttering systems. Implementing agencies still need to create more awareness about this technology because awareness creation forms the first and critical step in adoption of new technology.

Women and children should be involved in decision making because they are the most significant stakeholders in the adoption and implementation of Rain Water Harvesting Technology. Changing attitudes of community members towards women and children's involvement in development projects is crucial; this can be done through campaigns, advertising, word of mouth formal education or training.

Community members should form registered groups to facilitate access to the different devolved funds from the government such as the youth fund and initiate Rain Water Harvesting projects as Income generating activities i.e. harvest rain water and sell it to community members during the dry seasons.

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