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## Constraints to Use of Rainwater Harvesting Technologies as an Adaptation Strategy to Climate Change in Baringo County, Kenya

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### **Abstract:**

*The main objective of this study was to identify constraints to adoption of rainwater harvesting technologies (RWHT) as an adaptation strategy to climate change in Baringo County. The study used a descriptive survey design. Purposeful sampling and stratified proportionate random sampling procedures were used to obtain the sample. A total of 376 households were selected for the study. Questionnaire, key informant interview schedule and observations were the main instruments of data collection. Analysis of data was done using the SPSS. Percentages were used to analyze constraints to adoption of RWHT. Lack of finance is the main barrier to adoption of rainwater harvesting technologies in Baringo County. The income levels are generally low in the area and many households lack diversified sources of income. There is need to diversify income sources and improve access to formal credit facilities in order to relax households' financial constraints. This will promote adoption of the technology.*

**Keywords:** Constraints, rainwater harvesting technologies, adaptation, climate change

### 1. Introduction

Climate, with particular reference to rainfall, is known to be changing worldwide (Chaponniere & Smokhtin, 2006). According to Intergovernmental Panel on Climate Change (IPCC) (2001), the developing countries, Arid and Semi-Arid Lands (ASALs) and the poor in society are the most vulnerable and likely to be hit hardest by climate change due to their low adaptive capacity. Rainfall in Kenya is variable especially in arid and semi-arid lands (ASAL). Baringo County in Kenya is predominantly ASAL's and is prone to disasters. While Kenya, like countries in other parts of the world, have considerable experience in dealing with climate variability, climate change is likely to present them with new and tougher challenges. Consequently, the country needs to adopt new strategies to cope with new situations. The current technologies and approach especially in water are unlikely to be adequate to meet projected demands, and increased climate variability will be an additional stress (IPCC, 2001).

Adaptation to climate is not a new occurrence. Throughout human history, societies have adapted to climate variability and change (Burton, Diringer & Smith, 2006). However, there can be barriers and limitations to adaptation (Christoplos et al., 2009). Africa is one among many countries and regions in the world that are already taking actions that will help them manage the challenges of climate change. The approach that each has followed is specific to the context of the region or the country. Households especially in the more arid and semi-arid environments where rainfall variability impacts most strongly on water resources, have developed coping strategies to safeguard against the uncertainties induced by seasonal and annual rainfall variability. These strategies include: Access and use of seasonal rainfall forecasts, use of water conservation techniques, rainwater harvesting (RWH), using scarce water resources more efficiently, migration to new areas and protecting and restoring stream and river banks by building flood defenses and raising the levels of dykes (NRC, 2010; USEPA, 2009; EU, 2014; Yesuf et al., 2008; Smith, 2012; UNEP, 2006).

The rain water harvesting has the advantage of being low cost, relatively simple in design (household technology), less laborious and time saving (Alem, 1999). Rainwater harvesting is a very old technology and has been in parts of the world for more than 4000 years (Worm and Hattum, 2006). The technology is popular in rural Australia, parts of the United States, parts of India and Africa (Global Development Research Center, 2002). It has been used in Kenya for many years with most focus on the arid and semi-arid areas (ASALs) and rural areas (Otieno, 1994). Rainwater harvesting technology (RWHT) has been proposed as one of the options to improve water supply especially in rural and peri-urban areas of low-income countries (Opore, 2012; Cruddas, Carter, Parker, Rowe & Webster, 2013), as well as in all agro-climatic zones (Amha, 2006). However, the technology is more suitable in arid and semiarid areas (ASALs) (Branco, Suassuna, Vainsencher, 2005; Abdulla & Al-Shareef, 2009) to ensure water availability and access especially during prolonged dry season and drought (Enfors, 2009, Mugerwa 2007 and RELMA, 2007).

The adoption of Rainwater Harvesting Technology (RWHT) depends on a wide range of factors. According to Shikur and Beshah (2013), physical factors, household socioeconomic and institutional factors such as sex of the household head, family size, years of experience of household head, availability of labour, suitability of farm slope for runoff harvesting, type of soil, external support on rainwater harvesting practice, training on areas of rainwater harvesting technology, credit facilities, extension service on RWH practice, land security and income influence adoption of rain water harvesting technology. A technology must be accessible, affordable and appropriate for the target community

(Coventry, 2003) if it is to be successfully adopted and sustainably used. Institutions can play the most important role in learning and knowledge exchange, development of best practices, farmer support, and the management of RWHT systems (Nijhof et al., 2010) and may help provide the poorest households with resources needed for the adoption of the technology (Bunclark & Lankford, 2011).

Households with higher income and greater assets are less risk averse than lower income households, and therefore in better position to adopt new technologies (Shiferaw & Holden, 1998). Rosegrant et al. (2001) found that farmers in arid and semi arid areas do not widely adopt rainwater harvesting technologies because they do not have resources. The adoption rate of RWHT appears to be higher in areas where the government provides incentives for farmers, (Tumbo et al., 2010), although some forms of political intervention, such as social support, have been found to be unfavourable to the success of RWHT projects (Jodha, 1990). Income might be the biggest contributor to the water scarcity in Baringo County since majority of the population are poor with over 70% of the County's population living below the poverty line (RoK, 2006). Given that many households in Baringo County are poor, they are vulnerable to rainfall variability and climate change. These households cannot afford materials to construct water storage facilities or buy the ready-made facilities. High household income implies a greater incentive for investment in rainwater harvesting technologies and ability to bear the risks that can be associated with its adoption (Lloyd and Baiyegunhi, 2015). This study sought to explore constraints to adoption of rain water harvesting technology as an adaptation strategy to climate change in Baringo County.

## 2. Methodology

The study used purposeful sampling and stratified proportionate random sampling procedures to obtain the sample. Within Baringo County, the locations were stratified according to the agro-ecological zones. These are LM 5 (lower Midland), LH 2 (Lower Highland) and IL 6 (Inner Lowland). Lembus Central, Salabani and Ribkwo locations was purposefully selected for the study. They were selected because of having Agro-ecological zones LH2, LM5 and IL6, respectively to ensure proper representation of the respondents within the whole Baringo County area coverage. Lastly, random selection of the respondents within locations was made proportionate to the population of each location as per the household census report of 2009 (RoK, 2010). The study targeted 376 households which constituted 7.9 % of the total number of households in the three agro ecological zones. The selection of respondents was informed by household population by location level. This information was acquired from the County Development Officer at Kabarnet, the County headquarters. Lembus Central location has a population of 2,668 households, while Salabani has a population of 963 households and Ribkwo 1128 households. These were the three strata where proportional representation was obtained. 211 households in Lembus Central, 76 in Salabani and 89 in Ribkwo location was selected. A total of 376 respondents were selected for the study. Their participation during the interviews was, however, based on random sampling.

As for the key informants, purposive sampling was used to select those to be interviewed. These were selected from among meteorologists, NGO officers, chiefs, NDMA officers and water officers based on their positions of authority. These key informants were selected for the interview in consideration that they have insights on the subject of climate and use of RWHT by the households in the County.

The data were obtained from households and key informants through personal interviews by use of structured questionnaire and Key Informant Interview Schedule. The study focused mainly on household heads for interviewing to ensure uniformity of data collection process. The questionnaire was used to collect data from households on barriers to adoption of RWHT. The questionnaire was administered to all the 376 households in the study area. Key Informant Interview Schedule was used to collect in-depth data on adoption of RWHT. Observation was used to supplement and enrich data collected via the interview.

## 3. Results and Discussion

Baringo County faces a host of challenges that limit their capacity to devise effective adaptation strategies to rainfall variability. As shown in Table 1 below, households in Baringo County experienced challenges such as financial constraints (72 %), lack of information (40 %), inadequate rainwater harvesting structures (27%) and lack of technical skills and knowledge (26%) among others. During the interview, it also emerged that finances are critical to rain water harvesting and adaptation to climate change in general. Baringo residents observed that, even with basic skills and knowledge of adaptation, they are still vulnerable to climate change due to poverty. A fact that was supported by key informant interviews with chiefs and NDMA officers which revealed that most households in Baringo County lack diversified sources of income.

Limiting Factors				
	Yes		NO	
	F	%	F	%
Lack of information	150	40	226	60
Illiteracy	26	7	350	93
Traditional beliefs	5	2	371	98
Financial constraints	272	72	104	28
Unavailability of credit	52	14	324	86
Lack of RWH structures	64	17	312	83
Age of household head	5	2	371	98
Gender related disadvantages	10	3	366	97
Rainfall variability	65	17	311	83
Lack of technical skills and knowledge	96	26	280	74
Labour demanding	30	8	346	92
Inadequate RWH structures	100	27	276	73
Remoteness	5	2	371	98

*Table 1: Constraints to Adopting Rainwater Harvesting Technologies in Baringo County*

Lack of finance is the main barrier to adoption of rainwater harvesting technologies in Baringo County. Inadequate rainwater harvesting structures, rainfall variability, illiteracy, lack of technical skills and knowledge on RWHT, age and gender of the household head also influence adoption. According to Bryan et al. (2011); Shikur and Beshah (2013); He et al., (2007); Onwonga et al., (2013), lack of money or access to credit, lack of adequate structures and lack of information are significant impediments to adaptation to climate change. Rutten (1992) noted that there is need for diversified income sources in arid and semi arid lands (ASALs) as a strategy to enhance adoption of water harvesting techniques. Income improves household's financial capacity and increases the ability to adopt new technology. Access to formal credit facilities can relax households' financial constraints & expected to make households willing to participate in water harvesting activities (Molla, 2005).

Income might be the biggest contributor to the water scarcity in Baringo County since majority of the population are poor with over 70% of the County's population living below the poverty line (NCEA, 2015). These household cannot afford materials to construct water storage facilities or buy the ready-made facilities. The two main types of costs associated with RWH technologies are the initial investment costs and operating costs. These cover the cost of tools, labour, training which might be needed and other costs associated with investment and operating the techniques. Lloyd, (2015) noted that high household income implies a greater motivation for investment in rainwater harvesting technologies and ability to bear the risks that can be associated with its adoption.

Lack of technical skills and knowledge among the farmers can be attributed to the wide-ranging low levels of education in the County whereas lack of information can be attributed to inadequate training on rainwater harvesting systems. In most adoption studies, household heads with higher levels of education attainment are more likely to adopt or to practices rainwater harvesting techniques compared to less educated heads (Chianu and Tsujii, 2005). According to KRA (1998) major technical constraints towards the adoption and success of rainwater harvesting systems include; inadequate guidelines on the construction of RWH systems especially in the rural areas, inadequate technological transfer to the beneficiaries (in cases of donor funded projects) and lack of training programmes on rainwater harvesting for stakeholders (beneficiaries artisans). Poor technical selection and usage of local materials in construction of RWH systems and improper sizing of rainwater storage systems also limits adoption of RWHT (Wanyonyi, undated). Other factors include among others: inadequate water quality improvement structures, and limited technological transfer in rainwater harvesting at project level due to inadequate trained personnel in RWH.

Rainfall variability could be a limitation to adaptation in the sense that it can lead to the drying up and flooding of technologies such as wells, dams and water pans. Hence during extreme drought years, very little can be done to bridge a dry spell. Erratic rainfall and shortages leading to frequent drought spell, high evapo-transpiration rates have resulted to unreliability and unsuitability of many technologies. The open water storage including dams, pans and ponds, cannot sustain water for a long time due to the high rates of evaporation (Kimani et al., 2015). According to Campisano et al. (2013), frequent precipitation increases the performance of rainwater harvesting and that the water saving efficiency depends on storage tank size, demand fraction, storage fraction and climate. Also, Chao-Hsien and Yu-Chuan (2014a) observed that rainwater harvesting potential depends on climatic factors; quantity of precipitation being the most crucial factor. The study established that older household heads adopted rainwater harvesting techniques than younger household heads in Baringo County. According to Babbie (1973), as the person gets older he/she tends to intensify adoption of the technologies in his/her household. DTU (2002) also reported that households headed by elderly people have no interest to participate in rain water harvesting. However, according to Kimani et al., 2015 and Lloyd, 2015, older household heads are less likely to adopt rainwater harvesting technologies. Young members of a household have a greater chance of absorbing and applying new knowledge (Sidibe, 2005).

Households headed by males also adopted rainwater harvesting technologies than those headed by females in Baringo County. Women are less likely to adopt new technology (Adesina and Chianu, 2002; Kimani et al., 2015; Lloyd, 2015). According to Lloyd (2015), males can positively influence the adoption of RWHT because of bias against rural women inheriting land or having secure land rights. Security of tenure is a necessity for households to be able to carry out

long or medium term investment (Molla, 2005). Lawrence et al. (2002) also observed that gender of the household head is closely connected with the availability of water in household.

#### 4. Conclusion and Recommendation

Baringo residents experience the following challenges in adopting rainwater harvesting technologies: lack of finances, inadequate rainwater harvesting structures, rainfall variability, illiteracy, lack of technical skills and knowledge on RWHT, age, source of income and gender related differences. Lack of finance is the main barrier to adoption of rainwater harvesting technologies in Baringo County. Those households facing financial constraints were not willing to participate in water harvesting activities. Many households especially in lowland and midland lack diversified sources of income. Farming activities is their main source of income. Household income determines adoption of RWHT. Finances are critical to rain water harvesting and adaptation to climate change in general. Even with basic skills and knowledge of adaptation, people are still vulnerable due to poverty. Income improves household's financial capacity and increases the ability to adopt new technology. Improving access to formal credit facilities can relax households' financial constraints. Thus, to address adaptation to climate variability, high poverty levels in the area needs to be first addressed.

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