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Socio-Economic Factors And Adoption Of Rainwater Harvesting Technologies As An Adaptation Strategy To Climate Change In Baringo County

Koskei E.C

Department of Environmental & Life Sciences, Kabarak University, Kabarak, Kenya

***Abstract:** The main objective of this study was to identify socio-economic factors determining the adoption 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. Chi-square test statistic was used to analyze the relationship between socio-economic factors and adoption of rainwater harvesting. Income, education and age of household head significantly determined adoption. Education and income levels are generally low in Baringo County. The probability of adoption is also higher among older household heads than among younger household. Elderly people need to be targeted when promoting adoption. There is also need to diversify income sources and sensitize residents on the potential socioeconomic benefits of adopting rain water harvesting technologies. This will promote wider adaptability.*

***Keywords:** Socio-economic factors, rainwater harvesting technologies, adaptation, climate change.*

I. INTRODUCTION

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. Droughts are the most common disasters affecting Kenya (UNDP, 2016). Major droughts currently occur every ten years, and moderate droughts or floods every three to four years, with destructive results (NCEA, 2015). Intergovernmental Panel on Climate Change noted that Kenya will suffer more severe and frequent droughts in the 21st Century and the most vulnerable areas to climate change are the ASALs in the north and east including Baringo County situated in the northern regions of Kenya. In these areas, the population is poor and access to infrastructure and markets is low (NCEA, 2015). Increase in frequency of droughts will present major challenges for food security and water availability in these areas in spite of the country acting early to adapt to climate change by implementing the Kenya Arid Lands and Resource Management Project (ALRMP) (World Bank, 2007). Consequently, the country needs to adopt new strategies to cope with and adapt to new situations.

Adaptation to climate is not a new phenomenon. Throughout human history, societies have adapted to climate variability and change (Burton, Diringer & Smith, 2006). Many countries and regions in the world are already taking actions that will help them manage the challenges of climate change and Africa region is one of them. The approach that each has followed is specific to the context of the region or the country. A number of adaptation measures including rainwater harvest can be used to reduce vulnerability to rainfall variability. 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). Rainwater harvesting (RWH) has been proposed as one of the options to improve water supply especially in rural and peri-urban areas of low-income countries (Opare, 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. Institutional factors, household socio-economic characteristics and local climatic and agro-ecological conditions are the key determinants of adoption (Chilot, Shampiro & Mulat, 1996). The household characteristics that influence adoption decisions include age, education level, gender of the head of the household, household size, and source of income (Chilot *et al*., 1996). 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 socio-economic factors influencing adoption of rooftop rain water harvesting in Baringo County.

II. RESULTS AND DISCUSSION

SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENT HOUSEHOLDS

Understanding the gender of the household head is important in making decisions regarding household water availability and adaptation to rainfall variability. From the findings (Table 1), 64 % of the households sampled were male- headed while 36 % were female-headed. Most households were male-headed hence more households are likely to adopt rainwater harvesting technologies as an adaptation strategy to rainfall variability in Baringo County. Previous adoption studies have found that women are less likely to adopt new technology (Lloyd & Baiyegunhi, 2015; Adesina & Chianu, 2002) because female-headed households have limited access to resources (KNBS, 2010; Mbugua, 1997; Oppong, 1997; World Bank, 1991). Although most households were male-headed, it was noted that women were more concerned with quality and quantity of water based on gender division of work in the family. This finding therefore calls for involvement of women in adoption of the technology to respond to rainfall variability.

Age was clustered into 8 categories each with an interval of 6 years ranging from 18 years and the final category covered 60 years and above. In this study, 31 % of the respondents were aged between 18 and 30 years, 51 % were aged between 31 and 50 years, 11 % were aged between 51 and 60 years and only 6 % of the respondents were aged 60 years and above (Table 1). The results indicate that majority of the respondents were within the active and productive age range. They are in their prime age and in position to make crucial decisions regarding implementation of adaptation strategies to rainfall variability. They have better potential to be trained in adaptation mechanisms to rainfall variability. Older household heads are less likely to adopt the technology (Lloyd & Baiyegunhi, 2015). According to the theory of human capital, young members of a household have a greater chance of absorbing and applying new knowledge (Sidibe, 2005).

Demographic characteristics	Frequency	Percentage
Gender		
male	241	64
Female	135	36
Total	376	100
Source of income		
Wage employment	107	29
Self-employment	94	25
Business	98	26
Crop sales	77	20
Total	376	100
Education level		
No formal education	90	24
Primary	92	25
Secondary	132	35
Post-secondary	62	16
Total	376	100
Age bracket of household head		
18 and below	2	1
18-30	118	31
31-40	106	28
41-50	87	23
51-60	43	11
61 and above	20	6
Total	376	100
Household size		
3 members and below	34	9
4 to 7 members	241	64
8 to 10 members	85	23
11 members and above	16	4
Total	376	100

Source: Survey Data, 2015

Table 1: Distribution of households' Socio-economic characteristics

The main occupations of the household heads in Baringo County are shown in Table 1. About 29 % of respondents interviewed earned their livelihood from wage employment. About 25% of the respondents were self-employed while 56 % engaged in other forms of income generating activities such as crop sales (20 %) and business (26 %). The study also (Table 2) established that main source of income for households in highland (LH2) was wage employment (34 %), midland (LM5) was crop sales (41 %) and lowland (IL6) was livestock business (61 %). People in LM5 inhabit close to Lake Baringo. They combine rain-fed cultivation with supplementary irrigation while those in IL6 inhabit the northern part of the area and are heavily dependent on livestock and in particular goats. The ones in highland (LH2) settle up on the humid hills with good conditions for rain fed farming. Occupation influences the household's income and hence the amount of funds available to spend on water and rainwater harvesting structures.

Household size was recorded by the number of children and full time dependants in the household. Table 1 shows distribution of respondents according to the number of dependants within their households by categories. The greater proportion of households (64 %) had 4-7 members. Over half of this percentage had over 8 members. It would appear that majority of households have large families. Households with less than three family members constitute only 9 %. The study found that the smallest household size in the study area had one member and the largest household was composed of fifteen members. The average family size of the sample households, in this case, was found to be 7 persons, which is higher than the national average of 6 persons (Ministry of planning and National Development, 2008). Given that family labour is the main source of labour, large family households dominate the households and they may be motivated to adopt rainwater harvesting technologies in order to meet the high demand for water requirements.

However, it was noted that high numbers of members per family are mainly young people and this definitely is an indication of a high demand of resources to sustain big families in the area. The household size is important in adaptation to rainfall variability as it influences the adaptive capacity of the household. Households with more members are more likely to experience poverty (Kimenyi & Mbaku, 1995) than smaller households. A large household compounded with high level of poverty require a lot of financial resources for provision of basic needs. This eats the financial and natural capital that would have been spared for implementation of appropriate adaptation strategies to rainfall variability.

EDUCATION LEVEL OF THE HOUSEHOLD HEAD

The education level of the household head enables the household to acquire useful information on alternative water sources during dry periods due to ability to read and comprehend materials related to rainfall variability and adaptation strategies. Education improves the capability for resourcefulness and invention. Formal education can also provide a way of gaining employment, which is a source of income that can be used in implementation of adaptation strategies to rainfall variability.

Table 1 shows that 35 % of the sample respondents attained secondary education, 25 % attained primary education, and 24 % had no formal education while only 16 % had post-secondary education. The study established that the levels of education of household heads varied among the three agro-ecological zones of Baringo County. From Table 2, majority of the respondents (50 %) interviewed in highland (LH2) had attained secondary education, in midland (LM5) 45% attained primary education while in lowland (IL6), 66 % had no formal education. It was noted that most respondents dropped out of school after primary education in LM5 because of lack of school fees and search for employment to support the family because rain fed agriculture was no longer reliable while in LH2, most respondents did not attend school to tend cattle and goats and others felt that education is not important. Low educational attainment leads to low incomes hence less resources will be available for the implementation of adaptation mechanisms. The study findings indicate that education status is generally low in Baringo County and this negatively impacts on their adaptive capacity and vulnerability to effects of rainfall variability.

Variables	Agro-Ecological zones		
	LH2 (%)	LM5 (%)	IL6 (%)
Source of income			
Wage employment	34	7	32
Self-employment	29	36	7
Business	15	16	61
Crop sales	22	41	0
Total	100	100	100
Education level			
No formal education	5	26	66
Primary	20	45	19
Secondary	50	25	8
Post-secondary	25	4	7
Total	100	100	100

Source: Survey Data, 2015

Table 2: Distribution of respondents' source of income and education level by Agro-ecological zones

The study further sought to establish whether there was a relationship between socioeconomic factors and adoption of rainwater harvesting technologies (RWHT) by households in Baringo County. To find out the role played by socioeconomic factors on adoption of RWH technologies, a chi-square test was run between adoption of RWHT and households' heads background characteristics. Table 3 below indicates the results. Households' demographic and socio-economic characteristics play an important role in determining their technology adoption decisions and their livelihoods.

Demographic characteristic	Adoption of RWHT Yes	No
Age of the household head		
Below 18	0	1
18-30	12	19
31-40	14	14
41-50	13	10
51-60	8	4
61 and above	3	2
Education level of the household head		
No formal education	9	15
Primary and below	11	13
Secondary	18	17
Post secondary	12	5
Gender of the household head		
Male	34	30
Female	16	20
Source of income		
Wage employment	18	10

Self employment	12	13
Business	12	15
Crop sales	8	12
Household size		
3 members &below	3	6
4 to 7 members	32	32
8 to 10 members	13	10
11 members & above	2	2

Chi-Square Test

		Independent variables				
Dependent variable		Age	Gender	Education level	Household size	Income source
Adoption of RWHT	($\chi 2$)	13.3	1.95	18.77	19.86	13.54
	df	5	1	3	12	3
	significance	0.02	0.16	0.00	0.07	0.00

(n=376) Degrees of freedom (df) Pearson chi-square (χ2) Significance level=0.05

Table 3: Relationship between household heads' background characteristics and adoption of RWHT in Baringo County

There was a significant association between household heads' education and adoption of rainwater harvesting technologies by households in Baringo County. Highest education level attained by the household head has a statistical positive effect on the adoption of RWHT. The adoption was significantly influenced by the level of education of household head ($\chi 2$=18.77, *df* =3, p< 0.00). This is in-line with previous studies such as Kimani, Gitau & Ndunge, 2015, Tesfaye, 2006, Lloyd, 2015, Murgor, Owino, Cheserek & Saina, 2013 and Onwonga, Ahmed, Mburu & Elhadi, 2013 which have indicated positive effect on the adoption of RWHT. Only 9 % of the household heads with no formal education and 11 % who attained primary education had adopted rainwater harvesting technologies. This implies that most of the households (30 %) whom their heads had acquired secondary and post secondary education adopted rainwater harvesting technologies because low educational attainment leads to low incomes and economic status of households is closely linked with the affordability of services such as water.

Household income has a statistically-significant positive effect on adoption of RWHT that is the more income a household earns, the more likely the household will adopt rainwater harvesting technologies. The adoption of the technology by households was significantly influenced by income source of household head ($\chi 2$=13.54, *df* =3, p< 0.00). The findings are in agreement with those of Kimani *et al.*, 2015, Tesfaye, 2006, Lloyd, 2015 and Onwonga *et al*, 2013, which have indicated positive effect on the adoption of RWHT. About 18 % of the households whose main source of income was wage employment had adopted rainwater harvesting technologies. Only 8 % of the households whose main source of income was crop sales adopted the technology. This implies that household heads that mainly relied on income from farms had less likelihood of adopting the water harvesting techniques than those who had other sources of income apart from farms. Other studies in conclusion with this include that of Onwonga *et al*, (2013) in Yatta district, Kenya where amongst the factors that affected the adoption of rainwater harvesting techniques, the majority of the respondents had reported that the farm was the main source of their incomes. However, Herath and Takeya (2003) noted that the role of farm income on the decision to adopt is not clear. Hence, it is hard to predict the sign of farming as source of income.

The respondent's age was found to be significant and positively related to adoption of water harvesting techniques ($\chi 2$=13.3, *df* =5, p< 0.02). This is consistent with the findings of Onwonga *et al.*, 2013. However, the findings are in contrast with those of Kimani *et al.*, 2015 and Lloyd, 2015 where age has a statistically significant negative effect on adoption of RWHT, i.e., older household heads are less likely to adopt RWHT. Only 12 % of the household heads aged between 18 and 30 years adopted rainwater harvesting technologies. Majority of the respondents (35 %) aged between 31 and 60 years had adopted the technique. This indicates that the probability of adoption of rainwater harvesting techniques is higher among older household heads than among younger household heads. According to Babbie (1973), as the person gets older he/she tends to intensify adoption of the technologies in his/her household.

There was no significant association between gender of household head in Baringo County in relation to adoption of rainwater harvesting techniques. The adoption of the technique was not influenced by the gender of household head ($\chi 2$=1.95, *df* =1, p< 0.16). However, gender was statistically confirmed to positively influence the adoption of rainwater harvesting technologies within the ASAL areas by Kimani *et al.*, 2015, Adesina and Chianu, 2002 and Lloyd, 2015. Lawrence *et al.* (2002) also observed that gender of the household head is closely connected with the availability of water in household. According to Kimani *et al.* (2015), females can positively influence the adoption of rainwater harvesting technologies because they are more concerned with water issues while 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). According to Adesina and Chianu (2002), women are less likely to adopt new technology.

The adoption of RWH technique was not influenced by the size of household ($\chi 2$=19.86, *df* =12, p< 0.07). The significance level is above the significance level of 0.05, meaning that, there is no significant association between size of household and adoption of rainwater harvesting techniques by households in Baringo County. The findings are in contrast with those of Senkondo, Mdoe, Hatibu, Mahoo & Gowing (1998) who found the number of family members in a household to be one of the significant factors determining adoption of RWHT. Shikur and Beshash (2013) also observed a significant relationship between family size and adoption of RWH technologies. Applications of RWH techniques are sometimes labour intensive (Senkondo *et al.*, 1998). Given that family labour is the main source of labour in Baringo County, families with a small number of members working in the household are likely to be non-adopters.

III. CONCLUSION

Income, education and age of household head significantly influenced adoption of RWHT. Many households especially in lowland and midland lack diversified sources of income. Farming activities is their main source of income which may not be sufficient to implement some of the water harvesting techniques with regard to other competing uses. Education attainment is also generally low in Baringo County. Many household heads especially in lowland have either attained primary education or have no formal education hence they may not be aware of the technology. Income sources should also be diversified to improve household's financial capacity and increase their ability to adopt new technology. Educated household heads are more likely to adopt rainwater harvesting technologies. Therefore, school age going children should be encouraged to go to school. To promote better knowledge on RWHTs, rainwater harvesting should be introduced in school curriculum. The probability of adoption of rainwater harvesting techniques is higher among older household heads than among younger household heads in Baringo. Therefore, there is a need for policy makers and the private sector to target old people when promoting adoption. Some people lack information, technical skills and knowledge on rainwater harvesting. For effective implementation and subsequent adoption of rainwater, harvesting technologies, people would require technical knowhow and skills. In addition, people need to be mobilized and trained on the use of rainwater harvesting techniques and sensitized on the potential socioeconomic benefits of adopting them.

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