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THE CONSTRAINTS OF RAINWATER HARVESTING IN SOME SELECTED WARDS IN SABON GARI LOCAL GOVERNMENT AREA KADUNA STATE, NIGERIA

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ABSTRACT

Purpose: *The need for water for domestic and other uses has placed an increasing demand on the country's water resources in Nigeria. Sabon Gari local Government Area of Kaduna State has abundant water resources and a good potential for good groundwater storage but water scarcity still persists. This study is aimed at identifying the constraints and level of adoption of rainwater harvesting in some selected wards in Sabon Gari local government area of Kaduna State.*

Design/methodology/approach: *To achieve this aim, the study employed purposive sampling technique for the selection of wards and made use of structured questionnaire which was administered through the use of a software application known as kobo Collect to 400 randomly sampled respondents and was analyzed descriptively. The relative importance index (RII) was determined to know the constraints of rainwater harvesting (RWH) adoption.*

Findings: *The study found out that, small containers and buckets have a cumulative mean of (4.47) and drums with a mean of (4.38) showing that the harvested water is used for present use and also not aware of the modern way of harvesting rainwater through constructed systems, implying low adoption of rainwater harvesting and it is practiced at a traditional level. Amongst all the stated constraints to the adoption of RWH, low income with RII value of (1.82), low public awareness/education on RWH (1.66), and inadequate storage system (1.58), are the major factors that hinders the adoption of modern rainwater harvesting in the study area as indicated by RII.* ***Research limitations/Implications****: The study concluded that low adoption of modern rainwater harvesting in the study area indicates underutilization of the available water resources.*

Practical implications: *The study recommends the need for increased awareness and provisions of infrastructure for RWH by the Government and individual households for efficient utilization of RWH in the study area.*

Originality/value: *The study revealed the key aspect of socio-economic factors that needs to be addressed and therefore policies aimed at promoting RWH should be designed carefully taking socioeconomic aspect into account.*

Key words- water scarcity, rainwater harvesting (RWH), level of adoption, constraints to RWH, relative importance index (RII).

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1.0 INTRODUCTION

Water is a very important resource and part of our day-to-day activities. Water is considered an everlasting free gift of nature that can be acquired naturally. It plays a vital role in nearly every function of the body, protecting the immune system, the body's natural defenses and helps to move waste matter. It is essential in maintaining and sustaining human, animal and plant lives (Patil & Patil 2010). Being a critical and perpetual natural resource, water is essential for the health of every species on earth, socioeconomic prosperity of a country, food production, and environment (Boretti & Rosa 2019).

Despite the fact that water covers 70% of the Earth's surface, having proper access to water supply has become a multifaceted issue for nations throughout the world (Khatri *et al*., 2014). The world today is dealing with the issue of growing pressure on water resources due to increasing population and industrial development (Raut *et al*., 2021). It was reported that more than 750 million people do not have access to quality water and over 2.6 billion people feel the absence of basic sanitation in developing countries. For governments throughout the world, it has been a challenging issue to maintain proper access to water supply and sanitation (Krueger *et al*., 2019; Foster *et a*l., 2020; Kaini *et a*l., 2021). To deal with the water scarcity and work on filling the unmet water demand, many international organizations such as the Water Supply and Sanitation Collaborative Council, the United Nations, the World Bank and international aid organizations have been actively involved (UN Report, 2022). Scarcity of water in most parts of the world is usually driven by a number of factors causing shortage of potable water in most houses. In Africa, water scarcity is a menace and it has been estimated that by 2030, 75 to 250 million people will be living in water stressed areas (Musse, 2018). According to Orebiyi *et al.* (2010), a staggering fifty two percent (52%) of Nigerians have no access to improved drinking water supply.

Rainwater harvesting (RWH) is defined as "the process of concentrating rainwater over catchments through runoff to be stored and beneficially used" (Oweis *et. al*. 2012). RWH systems collect rainwater generated from roofs, terraces, and courtyards during rain fall events and store it in reservoirs to meet water demands for various uses (Zhang *e.t al*. 2019; Teston *et. al*. 2022; Jegnie *et.al*. 2023). Wartalska *et al. (*2024) in his study stated that RWH is a solution that brings both financial and environmental benefits, so also a number of studies (fisher-jeffes,2015; Ghanashyam *et al*.,2020; shazwan.,2020) have shown that RWH could provide a substantial water source across the continents. The progressive climate change led to a necessity of finding alternative water sources, and collecting rainwater is a great solution to meet the water demand and decrease surface runoff of excess rainwater. Rainwater harvesting is an old age practice and considered as one of the most promising and economically smallscale technology in augmenting water for domestic uses in every homes.

According to a survey carried by the local investment plan for Water, Sanitation and Hygiene (WASH) Department of Sabon Gari Local Government Area in 2018, it was noted that the main source of water facility in the local government is the borehole (hand pump borehole) constituting 74.3% of water points in the LGA with 60.2% of these improved water points functional, yet 74.3% of people living in the LGA do not have any access to basic improved functional water supply services. In order to access the nearest water supply facility, they have to travel an average distance of 1.6 km. Also, less than a per cent (0.7%) of water systems have provisions for persons living with disability. Water tariff systems are in place in only 2.2% of the facilities, with the predominant tariff system being per container (80%). Despite the fact that Sabon Gari LGA enjoys 4-5 months of annual rainfall, with ample potential for RWH, there seems to be low level of adoption of RWH as an alternative for water supply in the area. Though many studies have been carried out on rainwater harvesting especially in western and eastern parts of Nigeria, but little knowledge is known on the potentials of rain water harvesting in Sabon Gari LGA. This is therefore the gap which this study intends to fill. This study is aimed at assessing the constraints hindering the adoption of rainwater harvesting in the selected wards of Sabon Gari LGA, Kaduna State.

2.0 LITERATURE REVIEW

Studies have been conducted on establishing the factors hindering the adoption of rainwater harvesting, which have proven to have an effect on adoption. These includes government polices technological changes, market forces environment concerns, demographic factors, financial factors, socio-economic e.tc. According to Afsari *et. al* (2022), he conducted research on, Opportunities and Barriers Against Successive Implementation of Rainwater Harvesting Options to Ensure Water Security in Southwestern Coastal Region of Bangladesh and revealed RWH as the most appropriate supplementary water source in this region. The substantial factors which enhanced the acceptance of RWH in the water-scarce area were the accessibility of water compared to other sources, improved livelihood potential, security against climate change, and provision from local government and NonGovernment Organizations. Also, there was enough quantity of water to support the total water need in household activities. In another studies Bessah *et. al* (2022) on the Factors affecting farmers' decision to harvest rainwater for maize production in Ghana found out that male farmers, farmers with primary education, largescale farmers, experienced farmers, and those with access to weather information are more likely to harvest rainwater, while older farmers, those with limited access to extension services and labor, and those who perceive changes in rainfall pattern and amount of rainfall are associated with a lower probability to harvest rainwater for maize production.

Akroush *et. al* (2017) in his studies found out that educational level and years of farming experience significantly positively influenced the adoption of rainwater harvesting while the land tenure system had a negative significant influence on the likelihood of adoption in Jordan. Educational level, physical assets, and membership in organizations had a significant positive correlation with the decision to adopt the rainwater harvesting technique in the Makwanpur district of Nepal, Adhikari *et. al* (2018). Lutta *et. al* (2020) revealed that access to extension services and training, monthly income, land ownership, social group membership, and availability of active agricultural labor significantly influenced the adoption of rainwater harvesting technologies in Kenya. Mangisoni *et. al* (2019) also stated that the adoption of rainwater harvesting technologies in Malawi was significantly correlated with land slope and quality, farm size, soil texture, land tenure security, education, and support from extension services. Mekuria *et. al* (2020) showed that education, family size, farming experience, participation in technology demonstrations, and association membership significantly influenced the adoption of rainwater harvesting technologies in Ethiopia.

In Nigeria various studies have been conducted on rainwater harvesting, for example Shittu *et. al*., (2015) carried out research in Ibadan Oyo state, which he stated that RWH technology is a viable and reliable water supply option in both urban and rural areas for domestic purposes. (Omolara & David, 2013), stated that n Ibadan RWH is found to be technically feasible based 33 on the prevailing rainfall pattern. This study also stated that over 90% of households have a rooftop constructed from tactically appropriate materials which indicates that an average roof of 80msq will collect 82,835L/yr (45L/ person/ day) for a family of five people, which is near the water demand for drinking and cooking purposes. Tobin *et. al.,* (2013) also assessed the practice of rain water harvesting in a rural community in Edo state, which shows that RWH was practiced by over 80% of households, with the roof top as the catchment area, and the stored water was most commonly used for personal hygiene purposes. Ohiambe *et. al*., (2018) conducted research on the assessment of surface rain water harvesting potential in Abuja and stated that after considering an increase rainfall from (1170-1470 mm) in 2016 to (12301910mm) in 2046. Expansion in built up areas, bare surfaces due to urbanization and population growth, shows that Abuja will have a minimum of 5.8 billion L of water harvestable from rainfall per year which is about 14.8 % increase compared to the estimated harvestable quantity for 2016. An international colloquium on Water Research 2020 has reported a successful project by NAHRIM on rainwater as drinking water with several water catchment areas and incubators to process the rainwater (Mohamad, 2020). According to Law & Bustami (2013), Belmeziti *et al*., (2014) and Md Lani (2018), rainwater harvesting (RWH) is the best solution and alternative water supply too. By having systematic RWH, it can minimize water scarcity consequences and value for socio-economic (Md Lani, 2018), prolong the water storage during dry periods (Kuok & Chiu, 2020) improve household water management in the rural area (Nasif & Roslan, 2016), and for landscaping and agricultural purposes (Lee *et. al*., 2016).

3.0 THE STUDY AREA

Sabon Gari LGA is one of the major LGAs in Kaduna state. It is located the guinea savannah zone of the northern Nigeria, latitudes 11°6′60.00″N and longitudes 7° 43′59.99″E. It is 660 meters above sea level with a total land area of approximately 600km square. The population of Gabon Gari LGA is estimated to be 291,358 (NPC, 2006). It has a tropical continental climate which falls under the A_w of Koppens climate classification with a mean daily maximum temperature which gets to its peak in April and drops to minimum in October. The mean minimum temperature of 11°C occurs in December and January and high temperature of about 40ºC in July and August. Sabon Gari enjoys a tropical savannah climatic type, dry season practically varies and wet season with high sun. The mean annual rainfall is about 1200-1500mm (Oluwatoyin, 2013), it is underlain by igneous rock such as granites (mainly, the older granites), gneisses, migmatites and meta-sediments. The Galma river is a major tributary of river Kaduna. All other streams are seasonal, flowing only during and after the rains. There are two types of drainage basins in the area, the first is high stream frequency and drainage densities, examples are Rivers Kubani and Saye. The second consists of basin with low frequency and drainage densities such as Awai, Marmara, and Kuban (Oluwatoyin, 2013). The soil of the area is predominantly of the leached ferruginous tropical type which is derived from both the basement complex and the sedimentary rock. The vegetation is of guinea savannah and characterized by relatively dispersed trees surrounded by thick bushes of grasses and shrubs (Jaiyeoba, 1986). Dominant among the trees found around residential areas are *Isoberlina Doka*, *Tamarindus Indica* and *Adansonia digitata*. Some of the grasses found in the study area are *Hyparrheria spp, Schizochyrium smiberbe and Andropogan spp*.

4.0 MATERIALS AND METHODS

The study used both primary and secondary sources of data. The primary data was sourced by the use of a structured questionnaire in digital format through the use of a software called Kobo Collect. The 2006 population of Sabon Gari LGA being 291,358 was projected to 2022 using Newman's (2001) method (see equation 1) to get new population (431,226) and a total sample size of 400 was derived by using Yamane (1967) formula (see equation 2) for sample size. Furthermore, proportional allocation of sample size to each of the selected three wards was achieved using the formular in equation 3. Purposive sampling technique was used to identify the three wards with significant water scarcity status; based on the reconnaissance survey for this study in 2022. The simple random sampling technique was employed to administer questionnaire to respondents in the streets of the selected wards.

$$P_n = \text{po} + (1 + \frac{\text{R}}{100} \times \text{Po})\text{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Pn = population in the recent year
Po = population in the base year
R = annual growth rate n = number of intermediary years.

Sample size =

$$n = \frac{N}{1+N\,(e)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

n = Sample Size; N = Population size; 1 = Constant e = The level of precision

$$Sample\ size\ per\ ward = \frac{ward\ population \times sample\ size}{total\ selected\ ward\ population} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The level of adoption of Rainwater Harvesting in the study area was achieved using descriptive statistics by ranking of adoption (No = 1, Rarely =2, Sometimes = 3, Seldom = 4, Always = 5) and the arithmetic mean score were calculated i.e (1+2+3+4+5/5 = 3) which was used as the significant midpoint level of RWH adoption. Standard deviation and Coefficient of variation were used. The Relative Importance Index (RII) was used to assess the factors hindering the adoption of RWH in the area.

RII sum of weight is presented in the formula:

$$RII = \frac{\sum(W_i \times n_i)}{A \times N} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

W_i = weight of assigned to a specific response choice n_i = total count for a specific response choice
A = highest weight (in this case, 5)
N = Total number of respondents

The midpoint score was determined based on: 5+4+3+2+1 = 15/5 = 3; implying that any score greater than 3.0 is regarded as significant, while scores less than 3 is regarded as insignificant.

5.0 RESULT AND DISCUSSION 5.1 Demographic Characteristics and socio-economic of Respondents

This section presents the result of the data gotten from the demographic characteristics and socioeconomic status of the respondents; which includes gender, age group, educational qualification and monthly income as shown in Table 1.

Table 1 Demographic and socio-economic Characteristics of Respondents

	Bomo		Zabi		Samaru		Total	
	Freq		**Freq**		**Freq**		**Freq**	
Gender	**(%)**		**(%)**		**(%)**		**(%)**	
Male	63	**35.8**	48	**41.74**	40	**41.74**	151	**37.75**
Female	113	**64.2**	67	**58.26**	69	**58.26**	249	**62.25**
Total	**176**	**100**	**115**	**100**	**109**	**100**	**400**	**100**
Age group								
Missing value	2	**1.1**	0	**0**	0	**0**	0	**0**
15-19 years	5	**2.8**	6	**5.22**	0	**5.22**	11	**2.75**
20-29 years	50	**28.4**	26	**22.61**	18	**22.61**	94	**23.50**
30-39 years	53	**30.1**	47	**40.87**	33	**40.87**	133	**33.25**
40-49 years	42	**23.9**	33	**28.70**	54	**28.70**	129	**32.25**
Over 50 years	24	**13.6**	3	**2.61**	6	**2.61**	33	**8.25**
Total	**176**	**100**	**115**	**100**	**109**	**100**	**400**	**100**
Educational qualification								
O/level	73	41.5	28	24.34	35	32.11	136	34
OND/HND	45	25.6	49	42.60	32	29.36	126	31.5
1st degree	18	10.2	20	17.39	22	20.18	60	15
Master degree	0	0	0	0	0	0	0	0
Doctorate	0	0	0	0	0	0	0	0
Others (non-educated)	40	22.7	18	15.65	20	18.35	78	19.5
Total	**176**	**100**	**115**	**100**	**109**	**100**	**400**	**100**
Monthly Income								
Missing value	0	0	2	1.74	0	0	2	0.5
<10,000	0	0	12	10.43	10	9.17	22	5.5
10,000-30,000	124	70.5	44	38.26	33	30.28	201	50.25
30,000-100,000	48	27.3	55	47.83	65	59.63	168	42
100,000-150,000	4	2.3	2	1.74	1	0.92	7	1.75
150,000-200,000	0	0	0	0	0	0	0	0

>200,000	0	0	0	0	0	0	0	0
Total	**176**	**100**	**115**	**100**	**109**	**100**	**400**	**100**

Source: field survey, 2023

Table 1 shows the distribution of respondents based on sex and age group and it reveals that most of the respondents were females with about (64.2%), (58.26%) and (58.26%) respectively, giving a cumulative of 62.25%. This is because most of the respondents encountered were housewives who were believed to know everything about the use of water in the house and considering the nature of their ethnic group where women do not take part in most of the decision making in the house which might be a hindrance to the adoption of RWH. Aziz & Tesfaye (2012) made similar conclusion where the female headed households hardly have the privilege to own an RWH pond. Bessah *et.al (*2022) in his study shows that Male maize farmers were found to be more likely to harvest rainwater for maize production compared to their female counterparts. The female counterparts due to their common responsibilities to the household observed in the study areas may turn to harvesting rainwater for domestic purposes than farming. Having water at home reduces the workload to be done by the female and children of the house in ensuring that there is water for cooking and other house chores. In other countries, gender was also a significant factor in the decision to adopt rainwater harvesting in Malawi (Mangisoni *et al*., 2019) and in Kenya (Kimani *et al*., 2015). However, in Kenya, women were more likely to adopt rainwater harvesting technology than men because the study considered rainwater harvesting for all activities including domestic chores.

The age range of 30-39 years constituted the highest proportion of respondents with (30.1%), (40.87%) and (40.87%) respectively giving a cumulative of (33.25%), as indicated in table 1 this is because of the area is dominated by the Hausa ethnic group where women get married at a very young age. Bessah *et al* (2022), in his study was on the view that when farmers grow old, they usually become more limited to keeping on water management activities for maize production as rainwater harvesting and usage are labour-intensive activities, unless they have employees or appropriate machinery to reduce labour. In contrast to Southern Ghana, age significantly positively correlated with farmers' decision to adopt rainwater harvesting technologies (Mume & Kemal, 2014). A study by Kariuki (2011) also concluded that majority of the respondents were within active age bracket of 30 -50 years meaning that they could easily participate in the introduced technologies on RWH. According to López Felices *et al* (2023) he stated that older farmers are often reluctant to change their usual way of managing the farm when they feel that they are doing well, in addition to the fact that at an older age learning and implementing new techniques and practices are more challenging.

Educational status of the respondents as shown on table 1 revealed that a high percentage of the respondents have attended one form of formal education or the other with about (41.5%), (42.60%) and (32.11%) and total of 34% of all the respondents having o/level which implies that most of the respondents do not have enough educational qualification that might influence their adoption of RWH, education can be seen as a positive impact on the adoption both through public education and government aid and involvement of community leaders could be comprehended. Aziz & Tesfaye (2012) also made similar conclusion adopters of RWH technology have better education status than their counterparts. A study by (Ahmed *et al.,* 2013) was also of the view that Household head's formal education has a positive effect on adoption of water harvesting structures because it enhances management skills and ability to utilize information. Afsari *et al* (2022) in his study stated that knowledge concerning RWH use and utilization is insufficient and outdated, which obstructs the benefits of rainwater harvesting. Conforming to different studies (Baiyegunhi 2015; Mango *et. al*.

2017; Muriu Ng'ang'a *et. al*.2017), education helps the farmers cope with introducing new practices and technologies that involve adapting and making changes in their properties. RWH involves carrying out a more exhaustive control of the water parameters to maintain them at the appropriate levels for agricultural irrigation (Jewell 2016; Panageaetal.2016). For that reason, higher levels of education can facilitate the adoption of this practice.

As shown on the table, most of the respondents have low income of 10,000-30,000 Naira monthly which gives a cumulative of (50.25%) falling in that category makes adoption of RWH difficult for them. This could also be as a result of the low educational status which can also be deduced that the higher the education status of the respondents the higher their income which will in turn favour the adoption of RWH. Household income may have both a positive influence on adoption of water harvesting structures. Afsari *et al* (2022) in his study found out that 70% of the respondent are poor who have a monthly income >10,000 BDT, so therefore the initial cost of rainwater harvesting systems is dependent on the type of catchment, conveyance, tank size, and materials. The implementation cost of RWH system may be high but the long-term operation and maintenance costs are reasonable. Various studies be Aziz & Tesfaye (2012), Mbogo (2014), Florence, *et al.*, (2013), kariuki (2011) and kimani *et. al.* (2015) have shown that households with more income have enough capital to venture into more capital-intensive activities such as water harvesting structures.

5.2 Level of Adoption of RWH

The level of adoption of RWH was assessed by asking the respondents to indicate the type of storage techniques they use in harvesting the rain water which will determine whether the adopted technique is at a larger scale or at a local scale; the result is presented in table 2.

Table 2 Storage Techniques of RWH Storage Bomo Zabi Samaru Total RANK Techniques of

RWH	~~**X**~~	~~**CV**~~	~~**X**~~	~~**CV**~~	~~**X**~~	~~**CV**~~	~~**X**~~	~~**CV**~~	
Surface Tanks	**1.0**	0.00	**4**	0.00	**1.0**	0.00	**0.00**	0.00	**3rd**
Underground Tanks	**1.0**	0.00	**0**	0.00	**1.0**	0.00	**0.00**	0.00	**3rd**
Surface Reservoirs	**1.0**	0.00	**0**	0.00	**1.0**	0.00	**0.00**	0.00	**3rd**
Ground Water Recharge Pit	**1.0**	0.00	**0**	0.00	**1.0**	0.00	**0.00**	0.00	**3rd**
Drums	**4.7**	9.62	**4.4**	16.51	**4.2**	20.45	**4.47***	15.52	**1st**
Container Pans and Buckets	**4.5**	10.74	**4.2**	20.4	**4.3**	19.70	**4.38***	16.96	**2nd**

Note: **X**=mean, **CV**=coefficient of variation, *****= significant **Source:** field work,2023.

The above table shows that two among the six stated storage techniques have a significant mean ranking. However, respondents that store rain water with drums ranked 1st with a cumulative mean of 4.47 followed by those that store rain water with containers and buckets which ranked second with a mean of 4.38. This result shows that people that harvest rain water harvest it at local stage for the purpose of their daily water need and not for future purpose. Ghodsi *et. al* (2023) in his study stated despite the benefits of RWH, many traditional systems face critical limitations, including lack of storage monitoring mechanisms. Another study by Owusu & Asante (2020) which is in line with this study stated that, different forms of plastic tanks were available to users including buckets and water containers (gallons), which were used to store excess rainwater for a longer duration. Rainwater collected was normally used up between a couple of weeks to months until the next rain water harvest. The usage period of between 1–2 weeks (43%) and 1–3 months (40%) was the most common among residents. Respondents indicated that factors such as the small capacity of storage tanks, a high number of dependents, and also climatic conditions dictated how long rainwater lasts for households

5.3 Constraints to Modern Rainwater Harvesting

This section assessed the factors that are highly constrain the adoption of RWH and respondents were asked to indicate to which extent the following factors are a major constraint to them in terms of adopting the technology to help reduce their water scarcity during the dry season; the result is presented on table 3.

Table 3 Constraints to Modern Rainwater Harvesting

Constraints to RWH	Bomo ∑W×N	Bomo RII	Zabi ∑W×N	Zabi RII	Samaru ∑W×N	Samaru RII	Total ∑W×N	Total RII	Rank
Inadequate storage system.	634	**0.72**	397	**3.45**	318	**0.58**	450	**1.58***	**3rd**
Structural failure of storage system.	15	**0.02**	16	**0.03**	0	**0**	10	**0.01**	**12th**
Huge cost of construction.	361	**0.41**	60	**0.52**	56	**0**	159	**0.31**	**10th**
Contamination effect of rainwater.	68	**0.08**	291	**2.53**	254	**0.47**	204	**1.03**	**5th**
Loss due to seepage/evaporation in surface system.	0	**0.00**	20	**0.17**	0	**0**	6.7	**0.06**	**11th**
Lack of access to underground tank for repair and maintenance.	0	**0.00**	0	**0.00**	0	**0**	0	**0**	**13th**
Cultural, traditional/religious taboos or beliefs of users.	5	**0.01**	25	**0.22**	0	**0**	10	**0**	**13th**

Lack of adequate land area for constructing surface storage systems/other purposes after construction	5	**0.01**	0	**0.00**	0	**0**	1	**0**	**13th**
RWH culture is more of traditional method.	0	**0.00**	85	**0.74**	0	**0**	28	**0.25**	**8th**
Poor maintenance culture of end-users.	5	**0.01**	76	**0.66**	22	**0.04**	34	**0.24**	**9th**
Weak Policies on water resource management.	5	**0.01**	293	**2.55**	182	**0.33**	160	**0.96**	**6th**
Availability of other sources of water	197	**0.22**	324	**2.82**	442	**0.81**	321	**1.28***	**4th**
Cheapness of other Water Sources.	64	**0.07**	284	**2.47**	307	**0.56**	218	**1.03**	**5th**
Low income	619	**0.70**	461	**4.01**	415	**0.76**	498	**1.82***	**1st**
Lack of Water Management Laws.	2	**0.00**	20	**0.17**	185	**0.34**	69	**0.17**	**9th**
Low Public Awareness/ Education on RWH.	24	**0.03**	492	**4.28**	366	**0.67**	294	**1.66***	**2nd**
Tenancy status.	225	**0.26**	35	**0.30**	225	**0.41**	162	**0.32**	**7th**

Source: field survey, 2023
Note: N= Bomo=880, Zabi=575, Samaru=545

Table 3 represents the factors that are the constraints to the adoption of RWH in the study area cumulatively. Low income as indicated by RII was ranked 1st which implies that it is the major constraint to the adoption of RWH. Most of the respondent's income fall between 10,000-30,000 Naira which is very low when considering adopting RWH systems. Low public awareness/education on RWH as indicated by RII was ranked 2nd, most of the respondents were of the view that they are aware of traditional way of harvesting rainwater but that harvesting it through the use of constructed systems. Inadequate storage system was ranked 3rd which is also another significant constraint faced by most of the respondents because most of them use small containers and this can also be attributed to the reason that rain water is being stored for present use and not for future purpose. Aziz & Tesfaye (2012) reported that labour availability for the man is equivalent to indigenous water harvesting experience of the household, farm size of the household head, total tropical livestock unit owned, distance of market from residence, sex of the household head, off-farm income of the household head, training in areas of RWH, perception of farmers towards security of land ownership and extension service in areas of RWH are the significant factors that affects the adoption of RWH which contradicts the findings of this study.

A report by Kariuki (2011) also goes in contrary to this where he stated that, Gender preference in the community is the major challenge to adoption of RWH technologies, where most of the people in the community believe that women are responsible for the provision of water in the house, while the men are responsible to make decisions for development. Therefore, decision to invest in RWH technology will require that men be convinced of the benefits of saving time spent fetching water. He also stated other variables which were found to be significant such as roofing material, household income (financial constraint) and limited resources. Roy (2013) and kimani *et al.,* (2015) reported that one factors affecting the adoption of RWH is that most of the populations in the community are not in good financial condition, which goes in accordance with the result of study. In a study by (Apeksha *et al*., 2021), he stated that there is a dire need of creating awareness among the local population regarding current RWH potential as a dynamic alternative solution for water shortage which is line with this study on low education or awareness on RWH. In this study, 94 (80.3%) of the study population have moderate knowledge and about 15 (12.9%) of the study population have adequate knowledge and only 8 (6.8%) of the study population have inadequate knowledge on RWH. Zakaria (2019) and NAHRIM Research Centre (2020) stated that in order to encourage public participation in rainwater harvesting practice, government agencies and the mass media should promote the benefits and importance of rainwater harvesting and utilization through campaigns or by social media.

6.0 CONCLUSION AND RECOMMENDATION

The study concluded that low adoption of modern rainwater harvesting in the study area indicates underutilization of available water resources. The study recommends the need for increased awareness and provisions of infrastructure for RWH by the Government and individual households for efficient utilization of RWH in the study area.The study has established that level of adoption in the study area is done at a local scale because most of the respondents use small containers in harvesting the rain water mostly for their household chores such as washing clothes, watering their gardens, flushing the toilet, etc. Considering the level of adoption of modern rainwater harvesting in the study area, it can be concluded that adoption of RWH can be encouraged since it is one of the most promising sources of water and there is the knowledge of traditional way of harvesting rain. The study also established that the major constraints to the adoption of RWH in the area were low income, low public awareness/education on RWH, inadequate storage system and availability of other sources of water. This research presents valuable information that would help individuals at various households and government agencies (RUWASSA, WASH etc) in providing ways to reduce the problem of water scarcity in the study area. However, for it to be adopted a number of social and economic factors need to be addressed and therefore policies aimed at promoting RWH should be designed carefully taking socio-economic aspect into account.

The following recommendations are therefore made based on the result of this study:

- Increase awareness on the potentials of RWH especially at local community with the involvement of women participation. This is because women are the ones that use more of water in every household.
- Educational institutions and youth service should try and incorporate the rainwater harvesting skills in their schemes to make people at all levels aware of it potentials.
- Government and other private organizations should provide funds and technical assistance in building rainwater harvesting systems as most the respondents have low income which has been a major constraint to the adoption of such technology.
- The study further recommends that research be carried out on climate and the amount of rainfall received to ensure how much of rain can be harvested and stored for future purpose.

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