Indus Journal of Management & Social Sciences
Vol.2, No. 2: 87-98 (Fall 2008)

Rainwater Harvesting Potential for Domestic Water Supply in Edo State

S. I. Oni,[*] Emmanuel Ege,[*] Charles Asenime,* and S.A. Oke[**]

ABSTRACT

In the face of increasing scarcity of water resources, there is a need for communities to undertake audits of their current rainwater harvesting potential as a practical and promising alternative solution for water shortage. Despite the importance of rainwater harvest in socio-economic development of communities, very little information exists in the literature concerning it. This paper is an attempt to bridge this gap by examining the techniques and materials used for rainwater harvest with a focus on the geographical spread of its use and an analysis to support its wide acceptance by considering a case study from Edo State. Investigations also relate to health implications of rainwater harvest and impact on food production. Also, examined are institutional arrangements and policies guiding water supply and distribution in the state as opposed to rainwater harvest. The total volume of water supplied by the rain (in gallons), and the volume of conserved were evaluated from hydro-meteorological data collection system and through a survey in different senatorial districts of the state. The results of the analysis show that majority of the people empty their tanks mid-way into the dry season, suggesting that the current volume of the tanks is not enough to sustain the people with water during the dry season period. New constructions of bigger tanks are therefore recommended, particularly for families who use harvested rainwater for cassava processing.

JEL. Classification: J24; J43; O12; O13; Q15; Q16

KEYWORDS: Rainwater, Harvesting, Edo State, Stream, Tanks

IJMSS is published by Indus Institute of Higher Education (IIHE), Plot. # ST-2D, Block-17, Gulshan-e-Iqbal, Karachi-Pakistan

[*] Department of Geography, University of Lagos, Nigeria

[**] Department of Mechanical Engineering, University of Lagos, Nigeria
Corresponding author's e-mail: sa_oke@yahoo.com

Acknowledgements: Authors would like to thank the editor and anonymous referees for their comments and insight in improving the draft copy of this article. Authors furthur would like to declare that this manuscript is Original and has not previously been published, and that it is not currently on offer to another publisher; and also transfer copy rights to the publisher of this journal.

Date of Recieving: 0 1-02-2008; **Accepted:** 02-04-2008; **Published**: 01-09-2008

1. INTRODUCTION

In many developing and underdeveloped economies, public water supply to communities evidently provides a shortfall in demand. Coupled with the high level of poverty, particularly in rural and semi-urban communities of Nigeria, rainwater harvest presents a natural alternative that has extensively solved water supply problems of inhabitants of rural, semi-urban and urban communities in Nigeria. Motivated by the growing concern of various stakeholders in Edo State to solve the persistent water supply problem, this study presents an investigation on an alternative source of water supply in Edo State, termed roof-top rain harvest (RTRH). Particular attention is paid to the techniques and materials used for rainwater harvest in the state since very little information exists in the literature concerning it. What follows is the general literature relating rainwater harvest on a worldwide basis.

Rainwater harvesting research has been a dominant research area at the international science. Boers and Ben-ashen in 1982 reviewed 170 articles on rainwater harvesting between 1970 and 1980. Bruins, Evenari, and Nessler (1986) reviewed the role of rainwater harvesting agriculture (runoff farming) for arid Africa. Cheng, Liao and Lee (2006) developed a practical evaluation program for water conservation for architectural planning, particularly in building design. Also, there have been a large number of studies that have investigated rainwater harvesting in all the different parts of the world. Efforts have been made in Brazil (Adelia, Joao and Semira 2005), South Africa (Baiphethi, Viljoen, Kundhalande, Botha, Van Rensburg 2006), India (Kumar and Takoa 2004; Srivastava, Agarwal, Mehra, Tewari, Ramanujam, and Kulkarni, 2006), Nigeria (Efe 2006), Taiwan (Liaw and Tsai 2004), China (Li and Gong 2002), Sri Lanka (Ariyananda 1999), Kenya (Hogg 1988), USA (Cliff 1978), Nigeria (Akinola and Areola 1980; Whinomwe 1998) and Grenanda (Peters 2006). Adelia, Joao and Semira (2005) focused on the importance of rainwater harvesting to mitigate the scarcity of water in the semi –arid region of Brazil.

Baiphethi, Viljoen, Kundhalande, Botha, Van Rensburg (2006) investigated the impact of employing in field rainwater harvesting (IRWH) production technique on household food security for communal farmers in Thaba Nchu, by estimating the minimum area of land that a representative household needs to cultivate in order to meet its requirements. Kumar and Kakao (2004) evaluated the economic feasibility of agriculture with rainwater harvesting and supplementary irrigation in arid and semi-arid regions of India. Still on India, Srivastava, Agarwal, Mehra, Tewari, Ramanujam, and Kulkarni (2006) presented a care investigation of Bhabba Atomic Research Centre that has been able to create nearly 400 million litres of reservoir capacity by implementing Rainwater Harvesting measures.

Efe (2006) assessed the level of portability of rainwater samples harvested from catchment's roofs in 6 rural communities of Delta State, Nigeria. Liaw and Tsai (2004) identified four major parameters of rooftop rainwater harvesting system in Taiwan and elucidated it using a simulation method. Li and Gong (2002) studied the effectiveness of run off yield from compacted catchments with some local earth materials under the natural rainfall. Ariyanada (1999) investigated rainwater harvesting for domestic use in Sri Lanka. Peters (2006) assessed the potential of rainwater harvesting in the small Island of Carriacou (area $24km^2$) which forms part of the state of Grenada. The author shows that although per capita water demand is dependent on household income levels, rainwater can adequately meet the demands of the islands residents.

The structure of this paper is as follows: The introduction provides the motivation for the study and identifies gap in the literature, which justifies the pursuit of the current study. Section 2, which is methodology, reveals the approach undertaken in carrying out the study. The section 3 displays the results of the field study and data obtained from the reliable relevant sources. Section 4 presents concluding remarks.

2. METHODOLOGY

2.1 Site, Subjects and Procedure

Edo State, which is the study area, has between longitude $6^o42'$ and $6^o43'$E and latitude 5044'N and 7034'N of the equator. The state is composed of eighteen local government areas (Figure 1). Regarding physical characteristics, the Benin region is the most tilted, and slopes in a south-west direction with its highest elevation at Ishan Plateau. Its lowland is characterized by sandy coastal plain and alluvial clay with some hills in the east. The main rivers are Osse, Orhiomwon and Ikpoba, and they have their upper course steep with incised valleys. They are broad as they enter river Ethiope in Delta State. It is only River Osse that has a wide floor plain. Prominent in the area of study is the Ishan Plateau, which ranginess from 213m to 305m, and have numerous dry valleys, sand stone hills, and steep slopes in the northern and southern portions, but gentle slopes in the west. Another upland area is the Akoko-Edo dissected uplands, which range from 183m to 305m, and is characterized by granite peaks, which rise above 610m, and also erosional and stable land surfaces.

The study surveys locational sites of the roof water tanks, which were randomly selected. Consideration was given to the geo-political spread of the state by considering the three senatorial districts of the state (Edo South, Edo Central and Edo North), which tend to coincide with the climatic conditions of the state. Three local governments were identified in each senatorial district according to urban, semi-urban and rural status. From each local government, households were randomly picked where roof water tanks are constructed based on the income of the occupants, which is described as low, medium and high. An important water harvesting principle in the studied area is the ‘store and release’ principle. Here, the water is harvested, off impermeable surfaces such as roofs and pavements, referred to as collection structures. Concentration and conveyance are devices used in the study area to concentrate and direct flow of rainwater into tanks. Specifically, the devices called gutter with downspout and mechanical inlet filters are used. The earlier device is used to direct the water into the container, while the later is used to remove all trash before the water enters the tanks.

3. RESULTS

The results presented here relates to rainfall analysis from monthly rainfall measurement and dynamics, locational analysis of roof water harvest, and the general implication analysis relevant to the study.

3.1 Rainfall

For the area of study, there is a marked dry season, which is a duration increases from three months in the south of the state to five months on the Ishan plateau. The rainfall decreases from the southern part to north with less than 50inches of rainfall on the Ishan plateau Table 1 shows the rain distribution in Benin city, Edo State capital. This represents areas in the south sensational from 1980 to 2001. This data, collected from the Nigeria Meteorological Station, Benin, in 2002, show the monthly rainfall measurement and dynamics.

Table 1: Rainfall Distribution in Benin City

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1980	3.2	58.3	77.8	140.4	296.3	298.5	407.8	482.3	445.8	300.1	120.1	14.7
1981	5.6	6.8	108.4	119.8	277.2	180.6	276.1	230	394.8	178.1	12.9	1.1
1982	101.9	111.4	98.2	211.4	146	174.1	243.9	66.8	391	381.9	42.4	20
1983	4.9	49.4	39	76.8	267.4	277.2	166.5	142.8	425.2	50.3	29.8	22.8
1984	6.4	45.8	87.3	59.3	120.4	134.1	223.8	181.8	235.1	154.8	4.4	2.5
1985	8.7	16	110.5	33.2	173.4	202.5	244.3	305.2	197.9	147.5	106.1	50
986	5.6	45.1	109.4	52.3	162.7	65.1	214.2	117.7	231.3	166.5	67.1	30.2
1987	0.8	74.5	100.2	112.5	157.4	217	269.5	722.5	348.1	299.8	39.9	28.5
1988	7	71.1	154.8	136.5	168	227	393	191.2	445.4	273.2	23.3	58.6
1989	10	25.8	66.1	152	140.4	340	279.2	427.8	157.3	365.1	14.2	25.1
1990	19.6	18.8	55	256.8	181.4	204.1	353.4	614.5	296.9	289.9	33.7	68.6
1991	18.9	58.1	123.5	386.3	196.7	207.2	656.2	382.6	268	267.9	39.2	11.9
1992	0.3	0.2	41.4	222.7	240	335.8	515.9	76.4	256.3	292.2	35.6	16.1
1993	5.1	9.6	135	95.4	198.2	208.8	191.4	433.9	257.6	174.2	108.1	48.6
1994	27.5	14.6	111.4	149.8	327.9	351.3	444.4	461.2	391.8	204.5	43	21.8
1995	13	50.6	165.4	217.9	226.9	256.2	383.3	580.8	382.2	240.2	124.7	9.1
1996	7	92.6	188.2	298.2	322.2	281.1	182.3	392.3	476	292.7	5.6	1.1
1997	75.3	80	104	230.9	305.3	203.3	285	258	300	285	15.6	2.1
1998	44.1	1.8	104.6	104.8	214.6	214.4	506.1	95.6	387.9	244	58.8	42
1999	86.3	64.4	98.3	119.6	161.7	-	412.3	232	369	472.5	97.8	9.4
2000	4	73	60.8	170	191.8	413.7	294.7	237.9	345	351.2	49	48.7
2001	18.8	10.1	119.3	394.3	155.7	364.3	216	137.4	35.1	185	82.6	3.9

Source: Nigeria Meteorological Station Benin (2002)

In addition to Table 1, the data in Table 2 presents a 14-year rainfall distribution in Sabongida- Ora, which represents areas towards the north of the state.

Table 2: **A 14-Year Rainfall Distribution In Sabongida –Ora**
(areas towards the north of the state). Note all measurements are in millimeters

Jan	131.3
Feb	558.0
Mar	980.2
Apr	1974.6
May	2427.0
Jun	3121.7
Jul	3116.1
Aug	2042.7
Sept	2885.4
Oct	2372.1
Nov	304.0
Dec	163.3

Source: Nigeria Metrological Agency (2004)

3.2 Survey Results

From the survey carried 51 questionnaires were administered to the occupants of the houses where rainwater harvest tanks were located. However, only 31 occupants of houses responded. Thus, Table 3 shows the locations and distribution of rain water harvest tanks in the state. The information presented in Table 3 shows samples chosen, which indicate the precise locations in the specific local government areas, and the coordinates aided by the Global Positioning System (GPS). From the survey, it was observed that rain harvest tanks are not common in the urban centers due to (1) availability of portable water, and (2) The water table in the urban area is of low depth. Thus, in areas where portable water is not available, wells, which are dug augment the water supply. However, it is not that absolutely, there are no rain harvest tanks in the urban areas. It was observed that in the Government Reserved Areas (GRA) of Oredo Local Government Area, there is one rain water tank which serves domestic needs and the up-keep of a small poultry farm in the compound. Generally, rain harvest tanks are ubiquitous in the rural compounds.

In Oyebande (1977), the total water supply in the Bended state (now Edo and Delta) was put at 81.29 million liters per day. In a year, this would give 29,752, 14 million litres. Unfortunately, thus figure may not be correct in terms of the requirements of the state. Irregularity in this estimate must have been caused by the following reasons; (1) the data is now 31 year old. Since population of the state is not static but dynamic, the population growth of the state must have been affected. Thus prediction based on the old figures, (2) as the computation of the former Bended state is not the same as the current Edo State being studied.

Table 3. Locational Analysis Of Roof Water Harvest Areas/Points

No	Community	Ward	SD	Address l	LGA	GPS
1	Ekiadolor	04	Edo south	Benin-ekiadolor road	Ovia, NE	N06^0, 29.553’ E005 35.379’
2	Ekiadolor	04	Edo south	Benin-ekiadolor road	Ovia, NE	N06^0,29.70 E005,35.280
3	Ekiadolor	04	Edo south	Benin-ekiadolor road	Ovia, NE	N06^0,29.423’E005, 35.160
4	Ehor	01	Edo south	Auchi-Benin Road	Uhuenownde	N06^0,36.8221’E005,58.931
5	Ehor	01	Edo south	Auchi-Benin Road	Uhuenownde	N06^0,36.974’E005,58.929
6	Igieduma	03	Edo south	Auchi-Benin Road	Uhuenownde	N06^0,35.271’E005,56.933
7.	Igieduma	03	Edo south	Before odienwere’s house	Uhuenownde	N06^0,35.506’E005,56.898
8	Ihunmuduumu	05	Edo central	Ujulen Road, Ekpoma	Esan west	N06^0,44.354’E005,07.141’
9	Ihunmuduumu	05	Edo central	Ujulen Road, Ekpoma	Esan west	N06^0,44.344’E005,07.155’
10	Iruekpen	06	Edo central	Iruekpen	Esan west	N06^0,45.227’E005,03.158’
11	Iruekpen	06	Edo central	Iruekpen	Esan west	N06^0,45.181’E005,03.153’
12	Iruekpen	06	Edo central	Iruekpen	Esan west	N06^0,45.247’E005,03.154’
13	Irua	06		Irua Idumabo	Esan central	N06^0,43.984’E005,12.172’
14	Irua	06		Irua Idumabo	Esan central	N06^0,43.900’E005,12.960’
15	Irua	06		Irua Idumabo	Esan central	N06^0,43.914’E006,12.955’
16	Eko-ewu	08		Ewu	Esan Central	N06^0,46.265’E006,14.300
17	Aviele	07	Edo north	Benin okene expressway Aviele	Etsako west	N07^0 ,00.470E006,16.633’
18.	Aviele	07	Edo north	Benin okene expressway Aviele	Etsako west	N07^0 ,00.478E006,16.601’
19	Aviele	07	Edo north	Benin okene expressway Aviele	Etsako west	N07^0 ,00.466E006,16.711’
20	Ogbona	04	Edo north	Along auchi-fugar road	Etako central	N07^0 ,06.965E006,27.360’
21	Ogbona	04	Edo north	Along auchi-fugar road	Etako central	N07^0 ,06.999E006,27.444’
22	Fugar	02	Edo north		Etsako central	N07^0 ,05.644E006,29.802’
23	Fugar	02	Edo north		Etsako central	N07^0 ,05.649E006,29.786’
24	Iriakhor	05	Edo north	Ibadi road, fugar	Etsako central	N07^0 ,07.214E006,26.088’
25	Iriakhor	05	Edo north	Ibadi road, off achi road	Etsako central	N07^0 ,07.265E006,26.107’
26	Iriakhor	05	Edo north	Ibadi road, off achi road	Etsako central	N07^0 ,07.224E006,07.642’
27	Ihievbe			Afagba quarters	Owan east	N07^0 ,02.367E006,07’’ 642
28	Ivbiaro				Owan east	N07^0'02.557E006,207.642’’
29	Ivbiaro				Owan east	N07^0 ,02.552E006,10.274’’
30	Ugbowo		Edo south	Behind uniben	Ovai north east	N07^0 ,24.419E005,36.677’’

Table 4: Statistics of water pumped by State Water Board

Year	Estimated population	QQ of H_20 SS by state H_20 Board	Av. Per capita use per day	*Av. Shortfall per use per day	% Shortfall	% Supply
1992	2,213.844	171,250.490 m^3	8.761	36.241	80.53	19.47
1993	2,269.190	148,181.305 m^3	10.301	34.701	77.1	22.89
1994	2,325.920	165,246.875 m^3	13.331	31.671	70.38	29.62

*Assume 45 liters per person per day

Source:Ehinomen,1998

No caution was taken by the Federal Government of Nigeria in dividing the state according to its geographical features (such as climatic conditions), which affects rainfall that the current study investigates on; (3) several attempts (successful and unsuccessful) with respect to water-provision assisted projects have been made by both the government and international agencies, which obviously affect the need for rainwater harvest in the state. Even if we were to rely on the information provided by Oyebande (1977), then it was agreed that only 24% of the total population was provided with potable water (Akintola and Areola 1980). A further investigation by Ehinomer (1998) has given a breakdown of the quality of water pumped in each pumping station (head) for three years by the State Water Board as 171,250,490m^3 (1992), 148,181,305m^3 (1993) and 165,246,875m^3 (1994). Other information are provided in Table 4.

Though the figures provided by Ehinomen (1998) are old, very little addition of facilities and infrastructure to what the State Water Board has and what it now has have been made. Even, many of the facilities, which are rarely replaced, would have been old and inefficient in rendering the expected water service. Additional information from the Edo State Water Works indicates that the estimated amount of water required per person per day is: urban areas (125 liters/day/person), semi-urban areas (90 liters/day/person) and rural areas (45 liters/day/person). Here, since rain harvest is dominant in the rural areas, it is assumed that the requirement stated above is satisfied. However, from the questionnaire administered in the field, the minimum household size is 6, and would require 270 liters/day of water. Thus, the consumption in a month (using ratio and proportion) for this household would be 8100 liters. Consequently, the average volume of tank is 5000 gallons (22,250 liters). This asserts that since the average daily consumption is 45 liters/day, 6 people would require 8100 liters. If this consumption of water is restricted to the 6 family members, then the tank would then take 2 months 25 days to finish (using proportionality concept of mathematics).

On the other hand, the household with a size of 10 will consume 450 liters/day/person. The consumption in a month would be 450 liters x 30 days = 13,500 liters. It follows that for a tank of 22,250 liters capacity; it will take the family approximately 1 month and 20 days to empty the tank. This proves that the response obtained from the field is valid; that most homes start buying water from water vendors within two months of the last rain. This shows that the households in those areas where dry season last for more than four months would experience intense pressure to look for water for sustainability. Generally, it is observed that the volume of tanks provided for water is not wide enough to justify usage throughout the period of needs. This information is obtained from the data provided by Edo State Water Board and as indicated in the survey. The resultant effect is that within two months from the end of rainfall, the tanks become empty.

Information from the field survey shows that about 92% of the respondents that the buy water from vendors until the next rainy season. Correspondingly, only 8% of the respondents agree that the water takes them throughout the dry season. They claimed that they restrict access to the tank only to the members of their water available to than even throughout the dry season, this restriction was observed more in the high-in come group who, in most cases installed electric pump systems. This seems unlike the low and medium income group who use the manual system of fetching the water from the tank. Most owners in the groups of medium and low income groups sell water form the tanks.

From the questionnaires administered even though only 31.5% accepted that they sell the water from their tanks, majority of people in the low and medium income group are under pressure to assist their kinsmen or to sell the water for economic purpose. It was also observed that the house locations of the respondents are far away from the nearest streams; 50% of respondents are located more than 7km away from streams. This implies that it is difficult for these respondents to obtain water from streams for storage and usage. Figure 1 shows the graph of frequency and distribution of respondents with respect to distance from the nearest stream.

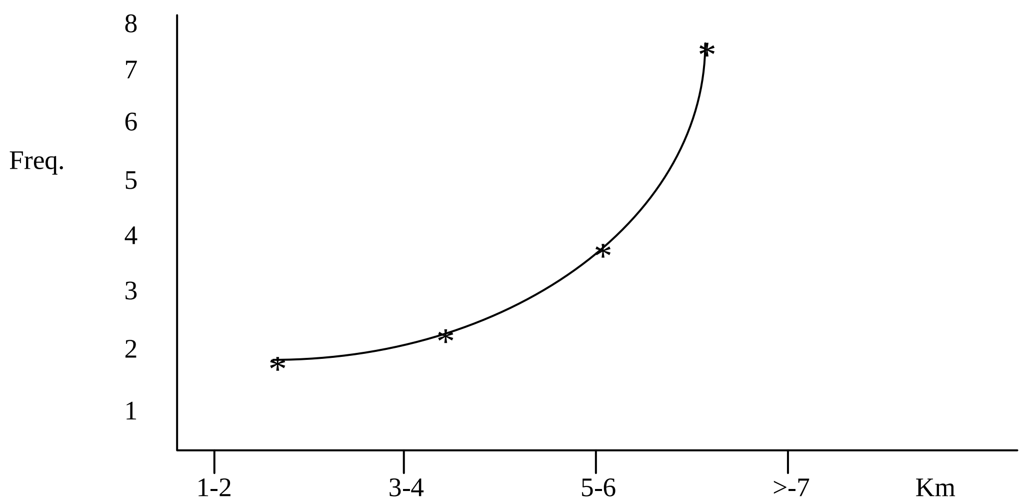

Figure 1. Frequency and distribution of respondents with respect to distance from nearest stream

It could be implied from Figure 1 that majority of the respondents live at locations which are 7km or more from the location of the nearest stream to them. It should be emphases that potable water supply is inadequate in Edo State and the people use rain harvest as an alternative to pipe-borne water.

3.3 Implications for Health, Food Security and Policy

Previous research asserts that water is an important medium for the transportation of toxins, viral and bacterial infections, which are injurious to the body. However, if some people do not boil water before drinking (rain or stream), there is a high risk of being infected with the above mentioned agents of diseases. The concern for not boiling water becomes serious with 93.8% of the respondents indicating that they do not boil the water before drinking. It thus appears that there is a very high risk that the population studies breaks down health wise in the nearest future if the habit of boiling water before drinking is not adhered to.

Rainwater harvest is obviously not an exception to the risk of disease transmission if not, boil. This may have motivated the growing global concern on the supply of good drinking water to all communities in recent times. This has also been highlighted in the United Nations declaration of 1980s, 1990s and 2003s as international year of fresh water, which was brought forward into 2004 as a result of its importance. Understandably, knowledge of the relationships among water quality, quantity and their effects on human health is growing among researchers and other stakeholders in the environment. Notably, a roof-water harvest permit contaminates. From the field, it was observed that about 98% of all the roofs surveyed are of rusted corrugated iron sheets, which permits dissolved minerals and particles in the water from the roofs to the tanks.

Another dimension of implications considered here relates to food security. From the information obtained in the field, it seems that serious rain harvesting activities in Edo State started in the 1980s. Although, there is no available statistics to correlate the volume of food production and the usage of modern water drawing facilities, however, it was observed that about 43% of households visited in Edo State have at least one of hand operated pumps, electric pumps and pulley system for drawing rain-harvested water from reservoirs, while 57% of households still employ the use of rope and bucket system to draw water from the reservoir (Table 5).

Table 5: Water Drawing Facilities in the Study Area

Facility	% Distribution
Hand operated pumps	15
Electric Pumps	7
Pulley system	21
Rope and Bucket	57

Source: Authors Field work 2003

The field study reveals that of the 43% of households that use some form of modern facilities, 45 % of them are engaged in large scale cassava production, this is as a result of easy accessibility to rain harvested water reserved in underground tanks. The water is used for washing the cassava tubers and soaking them for fermentation. With this arrangement, it is easy to employ other family members to join in the production. The remaining 55% of households use theirs strictly for private purposes. Of the 57% with Rope and Bucket, 95 % of households use it for large scale production of Cassava. Analyses show that many find it easy to peel the cassava at home and wash it there rather than going to the stream which is time consuming and energy sapping, as well as labor intensive. Analyses of responses reveal that home Garri producer process more than those who produce near streams and in farms while those who process their cassava at the farms and near streams produce an average of 3 (50kg) per day, and the one who process with rain harvested water produce an average of 7 (50kg) per day.

Home Cassava processing due to harvested rains is beginning to attain some level of local sophistication. For instance, an average reservoir of 4m deep by 1.5 m in diameter can hold water that can last for about 2 months and when exhausted water vendors with tankers come to replenish the stock thus joining in the growing chain of the factors of production. Also, in order to meet up with demands most Garri producers now buy cassava tubers from other farmers who are not able to optimally utilize their stock. This by extension is creating a new form of specialization in the industry that is expanding by the day. This form of division of labour if properly managed will positively influence food production in the state, thus engendering food security in the face galloping inflation and improve rural finance

With respect to policy formulation, it is worth noting that data acquisition, processing and storage have been problematic in this society. This can be shown from the number of data collection centers for weather elements. Edo state has 17 local government areas and only 3 monitoring stations are functional (i.e Ehor, Benin and Sabongida-Ora stations). It is therefore necessary that a bill should be passed which would make it mandatory for all Local Government headquarters and academic Institutions to have a meteorological station. Field observations indicate that majority of the people do not boil their water before drinking. Even though there are no confirmed records to show the relationship between the state of health of the people and reported cases of water transmitted diseases. Water- purifying dispensers (water logic) can be used at corporate and households levels. Water logic is available in various sizes and it is capable of filtering away the minute germs or dirt from water while reserving its natural tasteless form. There should be enlightenment campaigns to inform the people on the following: (1) the need to change their roofing sheets after a certain number of years because of rust which leaves traces of dissolved iron, (2) wash their tanks regularly especially before rainy season sets in, and preference for boiled water for drinking purposes.

4. CONCLUSION

Roof-top rain harvest (RTRH) has been a worldwide accepted culture, developed by people to conserve rainwater particularly in developing and underdeveloped economies where governments cannot provide adequate quantities of public water supply. RTRH is extensively utilized where all year availability of rainfall cannot be guaranteed. In particular, harvested rainwater is used for drinking, washing, food processing and feeding livestock. It is recommended that in order to evaluate the total volume of water supplied by the rain in gallons and the volume conserved through this system, a sophisticated hydro-meteorological data collection system must be adopted in the different senatorial districts. The result of the analysis in this paper shows that majority of the people empty their tanks mid-way into the dry season. This means therefore that the current volume of the tanks is not enough to sustain the people with water during the dry season period. New constructions of bigger tanks are therefore recommended most especially for families who use harvested rain water for cassava processing. Another strategy for the people to have enough water during the period is by understanding the pattern of the rain period. Accurate data collection for a long period of time would enable the people to know the last two weeks of rainfall and with this knowledge; they would see that their tanks are filled to the brim towards the end of the season.

REFERENCES

Adelia, B., S. Joao, V. Semira. 2005. Improving Access to Water Resources through Rainwater Harvesting as a Mitigation Measure: The Case of the Brazilian Semi-Arid Region. *Mitigation and Adaptation Strategies for Global Change*, 10(3): 393-409.

Akinola, F. O and O. Areola. 1980. Pattern and strategy of public water supply in Nigeria. *Nigeria Journal of Economics and Social Studies*, 22 (1)

Ariyananda, T.N. 1999. Rainwater Harvesting for Domestic Use in Sri Lanka, 25th WEDC Conference. Ethiopia: Addis Ababa, Ethiopia, 369-372.

Baiphethi, M.N., M.F. Viljoen, G. Kundhalande, J.J. Botha, L.D. Van Rensburg. 2006. Quantifying the Impact of In-Field Rainwater Harvesting (IRWH) Communal Farmers in Thaba Nchu. *Agrekon*, 45(3): 279-293. Free State Province

Boers, T.M., J. Ben-Asher. 1982. Review of Rainwater Harvesting. *Agricultural Water Management*, 5: 145-158.

Bruins, H.J., M. Evanari, U. Nessler. 1986. Rainwater Harvesting Agriculture for Food Production in Arid Zones: The Challenge of the African Famine. *Applied Geography*, 6(1): 13-33

Cheng, C.L., M.C. Liao, M.C. Lee. 2006. A Quantitative Evaluation Method for Rainwater Use Guidelines. *Building Service Engineering Research and Technology*, 27(3): 209-218.

Cliff, C.B. 1978. Engineering Aspects of Water Harvesting at the University of Arizona. *Proceedings of the Water Harvesting Symposium*, 27-39. Arizona: University of Arizona.

Efe, S.I. 2006. Quality of Rainwater Harvesting for Rural Communities of Delta State, Nigeria. *The Environmentalist*, 26(3): 175-181.

Ehinomen, C. 1998. The Use of Community Participation in Potable Water Supply in Nigeria: The Case of Edo State. *Nigerian Journal of Economics and Social Studies*, 40(1)

Gould, J. 2000. *Rain Water Catchments Systems for Domestic Supply. Design, Construction and Implementation.* London: Intermediates Technology Publications

Hogg, R. 1988. Water Harvesting and Agricultural Production in Semi-Arid Kenya. *Development and Change*, 19: 69-87.

Kumar, J.V., H.Takao. 2004. Significance of Rainwater Harvesting in Mega-Diversity Water Resource Country: India. J*ournal of Rainwater Catchments Systems, 10(1): 21-28.*

Liaw, C.H., Y.L. Tsai. 2004. Optimum Storage Volume of Rooftop Rainwater Harvesting Systems for Domestic Use. *Journal of the American Water Resources Association*, 40(4): 901-912.

Li, X.Y. and J. D Gong. 2002. Compacted Micro-Catchments with Local Earth Material for Rainwater Harvesting in the Semiarid Region of China. *Journal of Hydrology*, 257(1-4): 134-144.

Martinson, B. 2001. *Domestic Rain Water Harvesting in the Humid Tropics*. University of Warwick.

Oyebande, L. 1977. Water Resources: Geography of Development Heinemann. Education Books Ibadan.

Peters, E.J. 2006. Rainwater Potential for Domestic Water Supply in Grenada. *Water Management*, 159(3): 147-153.

Whinomwe, C. 1998. The Use of Community Participation in Potable Water Supply in Nigeria: The Case of Edo State, Nigeria. *Journal of Economic and Social Studies*, 40(1).

Srivastava, P.K., A. Agarwal, K.B. Mehra, PIK. Tewari, S. Ramanujam, P.B. Kulkarni. 2006. Rainwater-Harvesting Measures at BARC, Trombay Mumbai: A Case Study. *International Journal of Nuclear Destination*, 2(2): 158-165.

****