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RURAL FARM HOUSEHOLDS' PREFERENCE AND WILLINGNESS TO PAY FOR CLAY AND BIO-SAND WATER FILTERS IN NIGERIA

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Abstract
About 70 million rural farm households in Nigeria, out of a population of 180 million lacked access to safe drinking water. In achieving goal six of the Sustainable Development Goals (SDGs) 2030 of ensuring availability and sustainable management of water and sanitation for all, there is need to minimize water-related diseases among the rural farm households using Point of Use (PoU) water treatment systems such as clay and bio-sand filter. The study identifies factors that affect the desirability, acceptability and the amount the rural farm households are willing to pay for clay and bio-sand filters in the study area. The study area was Kaduna and Akwa Ibom states in Nigeria. Multi-stage sampling technique was used for the study. Descriptive statistic, Probit model, Tobit regression model and Choice–based conjoint analysis were used to analyze the data collected. The study revealed that clay filter was the most preferred because of the likeness of the filter design and material with preference index 0.78 and 0.75. The respondents were willing to pay ₦3, 930 ($10.9) for bio-sand filter. The willingness to pay for clay filter in the study area was influenced by age of respondents, educational level of respondents, estimated monthly income, employment status of respondents, awareness of clay filter, preference level of respondents and price of the clay filter. The study therefore, recommends that bio-sand should be improved upon with respect to its design, size, material, water volume and treatment to make it acceptable like clay filter.

Keywords: *Clay filter, Bio-sand filter, Rural farm households, Clean water, Nigeria*

Introduction
According to the World Health Organization (WHO), nearly 85 percent out of 1.8 billion population of the world lack access to healthy and uncontaminated water and live in rural communities which need safe drinking water (Naddafi *et al*, 2016). The crisis of water shortage is still the most important global challenge of the twenty first century especially among the rural farm households. In quantitative terms, although 75 percent of the earth surface is covered by water, fresh water has the share of only 3 percent of this amount, from which only one percent is available for different human uses (Hammer, 2015). Access to safe drinking water is essential to health and a fundamental human right. However, about 13% (884 million) of the people in the world lack access to potable water. Many people in rural areas of developing countries are not connected to municipal water facilities; hence they resort to self-help means of water supply. Most of the available water sources such as streams, rivers and wells have been impaired by anthropogenic activities, thereby rendering them unsafe for consumption (Freitas, 2013).

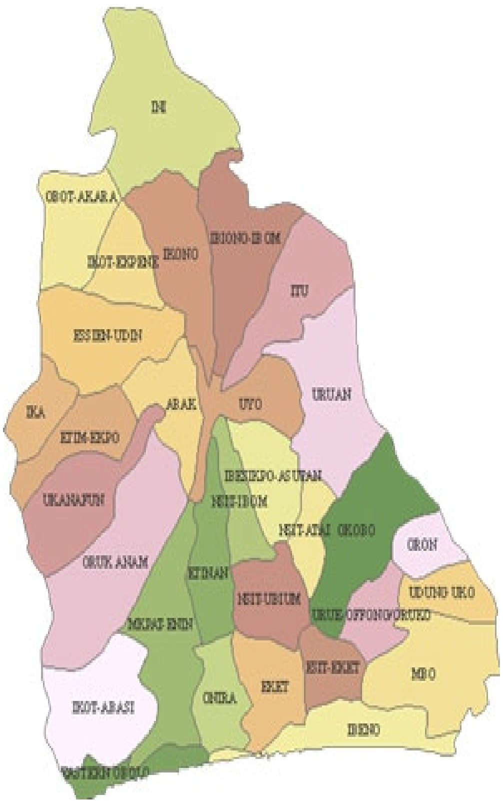
According to United Nations Children's Fund (UNICEF), (2016) Over 130 million people lack access to adequate sanitation in Nigeria, and almost 60,000 children less than five years old die every year from diarrhoea diseases caused by poor water and sanitation. About 70 million people in the rural area, out of a population of 180 million lacked access to safe drinking water, and over 105 million lacked access to improved sanitation in 2015 (Coster and Otufale ,2014). Open defecation rates, at 58.5 per cent among the rural farm households pose grave public health risks. Lack of adequate water and sanitation are also major causes of other diseases, including respiratory infection and under-nutrition in the rural communities (WHO, 2016). Safe drinking water and basic sanitation are crucial to the preservation of human health, especially children. Water-related diseases are the most common cause of illness and death among the rural farm households in developing countries, Nigeria inclusive (Erhuanga *et al*, 2014)

Again, in achieving goal six of the Sustainable Development Goals (SDGs) by 2030 of ensuring availability and sustainable management of water and sanitation for all, there is need to minimize water-related diseases among the rural farm households using Point of Use (PoU) water treatment systems. PoU treatment systems are water treatment systems used for treating water at the point of use, usually at household levels. PoU systems help to drastically reduce contamination associated with transmission and conveyance. In recent years, PoU systems have gained new-found popularity as solutions to water quality issues in the developing world. So, clay and bio-sand filter PoU systems can also safeguard against stored water contamination in the home through unsafe water handling practices, known to be a major cause of degraded drinking water quality (Nnaji *et al*, 2016). The study, therefore, identifies factors that affect the desirability, acceptability and the amount the rural farm households are willing to pay for clay and bio-sand filters in the study area. The study equally determines the awareness of clay and bio-sand filter, the preference level of the filters and the factors that influence willingness to pay for the filters in the study area. This is with the aim of promoting the use of natural resource like clay and sand to encourage the production of affordable filter among the rural farm household in Nigeria.

Materials and Methods

The Study Area

The study area was Kaduna State in the North Central of Nigeria and Akwa Ibom State in the South-South Nigeria. Kaduna State is made up of 23 Local Government Areas (LGAs). The States have a high density of human population of 6,000,752 with agriculture as primary occupation of the people. The Zaria LGA, which is one of the LGAs selected for the study is a major LGA in Kaduna State. Zaria LGA was created in 1976 with area of 563Km^2 with population of 612,257 and Chikun which is the second LGA selected for the study in Kaduna State was created in 1989. The LGA has a population of 368,250 as at 2006 census. Akwa-Ibom State is made up of 31 Local Government Areas (LGAs) (Adejuwon and Odekunle, 2014). The State has a high density of human population of 5,450,758 (NPC, 2007) with agriculture as primary occupation of the people. Akwa Ibom is located in the coastal southern part of the Country, lying between latitudes 4°32′N and 5°33′N, and longitudes 7°25′E and 8°25′E and total area of 7,081 km^2 (2,734 sq m). The State is bordered on the east by Cross River state, on the west by Rivers state and Abia State, and on the South by the Atlantic Ocean and the southernmost tip of Cross River State.



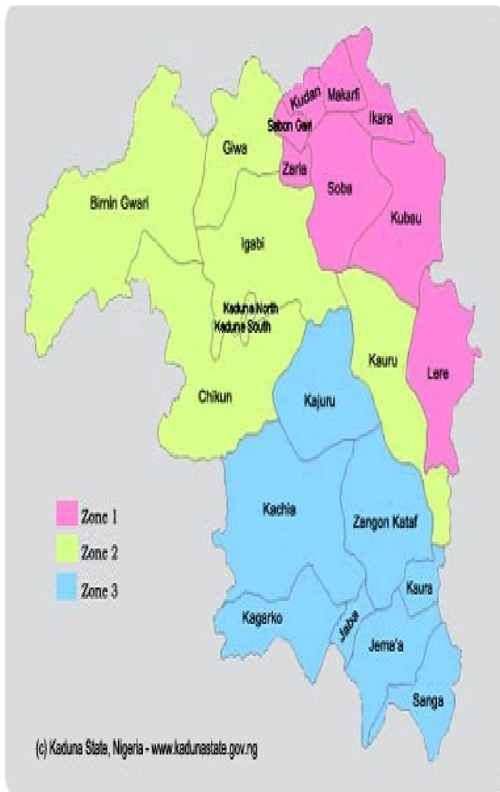


Figure 1: Map of Akwa-ibom and Kaduna State the Study Area

Sample and Sampling Techniques

A multi stage sampling technique was used in the study. Kaduna and Akwa Ibom State were purposively selected for the study because UNICEF Nigeria was implementing its projects on water and sanitation in the two states. Four Local Government Areas (LGAs) in each state were randomly selected for the study. In each LGA, fifteen (15) rural farm households were randomly selected through the assistance of the extension agents in each state (expert sampling). Again, 120 clay filters and 120 bio-sand filters were supplied to the identified rural farm households that were selected for the study. Each rural farm household has a clay and bio-sand filter installed in their house for the study.

Figure 1a and 1b are pictures of clay and bio-sand filter before installation used for the study.

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Figure 1a: Clay Filte r Before Installation

Figure 1b: Bio -sand Filter Before Installation

Figure 2 shows an installed clay and bio-sand filter in a rural farm household in the study area.

Figure 2: The Clay and Bio-sand Filter Set-up in a Rural Farm Household in the Study Area

Primary data were used for this study. The clay and the bio-sand filter were set-up in each respondent rural farm household, after a month, data were obtained through administering of structured questionnaire and interview schedule on the household. The dataset collected include: household socio-economic characteristics, awareness of clay and bio-sand filter, preference and willingness to pay for the filters, income of the respondents among others.

Data Analysis and Model Specification

Descriptive statistics comprising of frequency distribution, mean, bar char and percentages were used to describe the socio-economic characteristics of the households interviewed, the preference and the amount the households were willing to pay for clay and bio-sand filter in the study area. Probit model was used to determine the awareness of the respondents of clay and bio-sand filter in the study area. Probit model is appropriate when the response takes one of two possible outcomes. According to Gujurati, (2003) probit model is express thus:

$P_i[Y = 1] = [Fxi]$ --- (1)

Where $Y = \beta_0 + \beta_1 X_1$ ....(2)

Explicitly,

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_i$ ......(3)

Where,

Y_1 = Response with respect to awareness of clay and bio-sand filter in the study area (Dichotomous variable 1 = yes; 0 = no).

β_1 = vectors of unknown coefficients

X_i = Independent variables

X_1 = Age of respondent (Years)

X_2 = Highest educational level of respondent (No formal education = 0, adult education = 1, primary school education = 2, secondary school education = 3, tertiary education = 4)

X_3 = Household size (Number of person)

X_4 = Estimated monthly income (Naira)

X_5 = Employment status of respondent (Employed = 1, unemployed = 0)

X_6 = Age^2

X_7 = Access to safe water (within 1-4 kilometers = 1, otherwise = 0)

U_i = Error term

The preference for filter in the study area was measured using the following selected attributes: likeness of design, likeness of size, likeness of filter material, meeting household demand in term of volume and meeting household demand in terms of water treatment. This was measured using a scale of 1-5 (not preferred = 1, least preferred =2, indifferent = 3, preferred = 4, most preferred = 5).

Tobit regression model was used to examine the preference level of the respondents for clay and bio-sand filter in the study area. The level of preference was measured using the following attributes: likeness of design, likeness of size, likeness of filter material, meeting household demand in term of volume and meeting household demand in terms of water treatment. This was measured using a scale of 1-5 (not preferred = 1, least preferred =2, indifferent = 3, preferred = 4, most preferred = 5). The Tobit regression model is as specified below.

$Y_i^* = \beta_i X_i + U_i$--- (4)

$U_i = N(0, \delta^2)$

Y_i^* = latent variable representing levels of preference for clay and bio-sand filter

X_i = explanatory variables

β_i = vector of parameters to be estimated

U_i = normally distributed error term

Y_i = preference level of consumers for clay and bio-sand filter

$Y_i^* = y_i$ if $0 < y_i < 1$ (for those that prefer based on the clay and bio-sand filter attributes)

$Y_i^* = y_i$ if $y_i = 0$ (for those that do not prefer)

Explicitly,

$Y_i^* = y_i$ if $0 < y_i < 1$ (for those that prefer based on the clay and bio-sand filter attributes)

$Y_i^* = y_i$ if $y_i = 0$ (for those that do not prefer)

Explicitly,

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_i$------- (5)

The independent (explanatory) variables that were used in examining the preference level of respondents for clay and bio-sand filter in the study area were as specified below:

X_1 = Age of respondent (Years)

X_2 = Highest educational level of respondent (No formal education = 0, adult education = 1, primary school education = 2, secondary school education = 3, tertiary education = 4)

X_3 = Household size (Number of person)

X_4 = Estimated monthly income (Naira)

X_5 = Employment status of respondent (Employed = 1, unemployed = 2)

X_6 = Age^2

X_7 = Access to safe water (within 1-4 kilometers = 1, otherwise = 0)

U_i = Error term

Choice – based conjoint analysis was used to determine the price the respondents are willing to pay for the clay and bio-sand filter in the study area. Two prices (Upper and lower mark) (i.e. 5,000 Naira and 6,000 Naira) ($13.89 and $16.67) were set; respondents' willingness to pay was however determined by those that picked prices within the upper and lower price mark. A respondent is unwilling to pay if he or she picks below the lower price mark. Discrete choice approach using binary logistic model was used to analyze the factors influencing respondents' willingness to pay for clay and bio-sand filter in the study area. Respondents that picked prices within the set limit are assigned 1, while those that picked prices below the lower mark are assigned 0. The model is empirically estimated as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \ldots + \beta_{12} X_{12} + U_i$------- (6)

Where,

Y_1 = Response with respect to respondents' willingness to pay for clay and bio-sand filter in the study area (Dichotomous variable 1 = yes; 0 = no).

β_1 = vectors of unknown coefficients

X_i = Independent variables

X_1 = Age of respondent (Years)

X_2 = Highest educational level of respondent (No formal education = 0, adult education = 1, primary school education = 2, secondary school education = 3, tertiary education = 4)

X_3 = Household size (Number of person)

X_4 = Estimated monthly income (Naira)

X_5 = Employment status of respondent (Employed = 1, unemployed = 2)

X_6 = Age^2

X_7 = Access to safe water (within 1-4 kilometers = 1, otherwise = 0)

X_8 = Price of the clay filter

X_9 = Price of the bio-sand filter

X_{10} = Awareness of clay/bio-sand filter (Aware =1, otherwise = 0)

$Y_i^* = y_i$ if $0 < y_i < 1$ (for those that prefer based on the clay and bio-sand filter attributes)

$Y_i^* = y_i$ if $y_i = 0$ (for those that do not prefer)

Explicitly,

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_i \quad \text{-------} (5)$$

The independent (explanatory) variables that were used in examining the preference level of respondents for clay and bio-sand filter in the study area were as specified below:

X_1 = Age of respondent (Years)

X_2 = Highest educational level of respondent (No formal education = 0, adult education = 1, primary school education = 2, secondary school education = 3, tertiary education = 4)

X_3 = Household size (Number of person)

X_4 = Estimated monthly income (Naira)

X_5 = Employment status of respondent (Employed = 1, unemployed = 2)

X_6 = Age^2

X_7 = Access to safe water (within 1-4 kilometers = 1, otherwise = 0)

U_i = Error term

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$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \text{.........} + \beta_{12} X_{12} + U_i \quad \text{-------} (6)$$

Where,

Y_1 = Response with respect to respondents' willingness to pay for clay and bio-sand filter in the study area (Dichotomous variable 1 = yes; 0 = no).

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X_4 = Estimated monthly income (Naira)

X_5 = Employment status of respondent (Employed = 1, unemployed = 2)

X_6 = Age^2

X_7 = Access to safe water (within 1-4 kilometers = 1, otherwise = 0)

X_8 = Price of the clay filter

X_9 = Price of the bio-sand filter

X_{10} = Awareness of clay/bio-sand filter (Aware = 1, otherwise = 0)

X_{11} = Preference level of respondents (Index)

U_i = Error term

Table 1: Socio-economic Characteristics of the Respondents

Socio-economic Characteristics	Frequency	Percentage
Age in years		
41-50	38	31.7
51-60	39	32.5
Above 61	43	35.8
Total	**120**	**100**
Household Size		
0 – 5	80	66.6
6 -10	20	16.7
11 – 15	20	16.7
> 16	Nil	Nil
Total	**120**	**100**
Years of Living in the Community		
0-10	38	31.7
11-20	33	27.5
21 -30	28	23.3
>30	21	17.5
Total	**120**	**100**
Education Attained		
Completed Primary School	56	46.7
Completed Secondary School	40	33.3
Tertiary	24	20.0
Total	**120**	**100**
Annual		
Income of		
Respondents	43	35.8
(₦)	77	64.2
=50,000	**120**	**99.9**
51,000		
100,000		
Total		
Sources of		
Drinking		
Water	25	20.8
Hand Pump	68	56.7
Borehole	27	22.5
Well Water		
Pipe Borne	**120**	**100**
Water Within		
Public Sphere		
Total		

As shown in Table 2, 28.0% of the respondents in the study area knew that drinking unclean water causes dysentery and 26.0% of the respondents knew it causes diarrhea. While 23.6% and 22.4% knew drinking unclean water causes typhoid and cholera respectively. So the use of the filters on health ground is very important, this in line with the findings of Hammer, (2015) that some people are using filter to guide against water borne diseases?

Table 2: Distribution of Respondents by Knowledge of Diseases Caused By Drinking Unclean

Knowledge of Disease Caused By	**Frequency**	**Percentage**
		28.0
Drinking	95	23.6
Unclean	80	26.0
Water	88	22.4
Dysentery	76	100
Typhoid	339	
Diarrhea		
Cholera		
Total		

***Note: Multiple response**

Table 3 shows the determinants of the respondents' awareness of clay and bio-sand filter in the study area. A total of seven variables were included in the model, out of which four were significant at 1%, 5% and 10% respectively. Age of the respondents was positively related to the awareness of the clay and bio-sand filter in the study area and significant at 1% which follows apriori-expectation. This in tandem with the finding of (United Nation (UN), 2016) that awareness of Point of Use (PoU) water treatment systems such as clay and bio-sand filter is known mostly among older generation compare to the younger generation. Therefore, the probability of a respondent awareness and adopting PoU water treatment systems such as clay and bio-sand filter increases as age increases.

Level of education was also significant at 1% with positive effect on awareness of clay and bio-sand filter in the study area. This implies that the level of education of the respondents' have positive effect on their level of awareness of clay and bio-sand filter in the study area. Asia *et al*, *(*2015*)* stated that educational level of the respondents increases their awareness and exposure level, thus they will be more receptive to policy that leads to improve livelihood and welfare. Therefore, access to formal education tends to enhance the urge for new idea and new technology in which PoU water treatment systems such as clay and bio-sand filter is one. Access to safe water was statistically significant at 5% probability level with a negative sign. Given the negative sign means that the respondents who have access to safe water within 1 to 4 kilometer distance may likely not be aware of the clay and bio-sand filter in the study area. This buttresses the assertions of Frank and Benon (2016) that the goal six of Sustainable Development Goals (SDGs) is critically meant for those dwelling in the rural area of the Developing Countries (DC) of the World. Age^2 which gives an idea of what the response of a particular respondent will be in the future or as the person grows older had a positive relationship with the awareness of clay and bio-sand filter in the study area and was significant at 10%. Therefore, age^2 had a direct relationship with the awareness of clay and bio-sand filter which reveals that respondents will probably be more aware of the clay and bio-sand filter in the future. This supports the findings of Dontsop *et al., (2011)* that older people associated with health related problems are likely to be aware of safety labels PoU products like clay and bio-sand filter.

Table 3: Probit Estimates of the Respondents' Awareness of Clay and Bio sand Filter

Variables	Coefficients	Standard Error	P>/z/
Age of respondent	0.4146	0.1526	0.006***
Educational level of respondent	0.0429	0.0132	0.012***
Household size	0.0153	0.1403	0.997
Estimated monthly income	3.29e-07	4.68e-07	0.491
Employment status of respondent	0.0593	0.0207	0.004
Age^2	0.0035	0.0015	0.026*
Access to safe water	0.0533	0.0206	0.011**
Constant	-3.9927	2.0991	0.029

*** Significant at 1%; ** Significant at 5%; * Significant at 10%;
Number of observations = 108 LR ch^2 (8) = 29.09 Prob > ch^2 = 0.0096
Log likelihood = -72.66815

Table 4 revealed the preference level of clay filter by the respondents in the study area based on the selected attributes. It was revealed that clay filter was the most preferred because of the likeness of the filter design and material with preference index 0.78 and 0.75. According to the respondents, the filter was transparent, hence was very easy to monitor the level of water in the filter compare to bio-sand filter. While clay filter was least preferred because of meeting households demand in term of water volume with preference index of 0.59. Clay filter was the most preferred with mean index of 0.67

Table 4: Distribution of Respondents Preference Level or Clay Filter Based on the Selected Attributes of the Filters

	Clay Filter										
	NP		LP		I		P		MP		PI
Selected Attributes	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	
Likeness of filter design	20	16.7	7	5.8	0	0	33	27.5	60	50.0	0.78
Likeness of filter size	33	27.5	20	16.7	7	5.8	30	25.0	30	25.0	0.61
Likeness of filter material	7	5.8	13	10.8	0	0	60	50.0	40	33.3	0.75
Meeting household demand in term of water volume	27	22.5	33	27.5	13	10.8	27	22.5	20	16.7	0.59
Meeting household demand in terms of water treatment	13	10.8	20	16.7	0	0	54	45.0	33	27.5	0.61

Note: Not Preferred (NP) = 1, Least Preferred (LP) =2, Indifferent (I) = 3, Preferred (P) = 4, Most Preferred (MP) = 5 and F =Frequency, % = Percentage

Table 5 revealed the preference level of the bio-sand filter by the respondents in the study area based on the selected attributes. It was revealed that bio-sand filter was not preferred by respondents because the entire selected attributes preference indexes were below 0.50. According to the respondents, the filter was not transparent like clay filter, hence is not easy to monitor the level of water in the filter. Setting up the filter was cumbersome and process of maintaining the filter was difficult according to the respondents. Therefore, bio-sand filter was the least preferred with mean index of 0.46.

Table 5: Distribution of Respondents' Preference Level Based on the Selected Attributes of the Filters

	Bio-sand Filter										
	NP		LP		I		P		MP		PI
Selected Attributes	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	
Likeness of filter design	40	33.3	40	33.3	0	0	20	16.7	20	16.7	0.49
Likeness of filter size	33	27.5	47	39.2	0	0	33	27.5	7	5.8	0.48
Likeness of filter material	33	27.5	40	33.3	0	0	40	33.3	7	5.8	0.42
Meeting household demand in term of water volume	27	22.5	40	33.3	0	0	33	27.5	20	16.7	0.46
Meeting household demand in terms of water treatment	33	27.5	33	27.5	20	16.7	20	16.7	14	11.7	0.47

Note: Not Preferred (NP) = 1, Least Preferred (LP) =2, Indifferent (I) = 3, Preferred (P) = 4, Most Preferred (MP) = 5 and F =Frequency, % = Percentage

On the amount the respondents were willing to pay for the filters. Figure 3 revealed the ranges of amount the respondents in the study areas were willing to pay for the clay and bio-sand filter. As shown in figure 3, 4.2% of the respondents were willing to pay less or equal to ₦1,000 for the clay filter. From the same figure, 27.5% of the respondents were willing to pay between ₦1,001 and ₦2,500 for clay filter, 40.0% of the respondents were willing to pay between ₦2,501 and ₦5,000 for the clay filter and 28.3% were willing to pay above ₦5,000 for the clay filter. Therefore, on the average for the clay filter, the respondents were willing to pay an average of ₦5,200 ($14.4). For the bio-sand filter, as shown in figure3, 12.5% of the respondents were willing to pay less or equal to ₦1,000 for the bio-sand filter. 50.8% of the respondents were willing to pay between ₦1,001 and ₦2,500 for clay filter, 35.0% of the respondents were willing to pay between ₦2,501 and ₦5,000 for the bio-sand filter and 1.7% respondents were willing to pay above ₦5,000 for the bio-sand filter. On the average for the bio-sand filter, the respondents were willing to pay an average of ₦3,930 ($10.9).

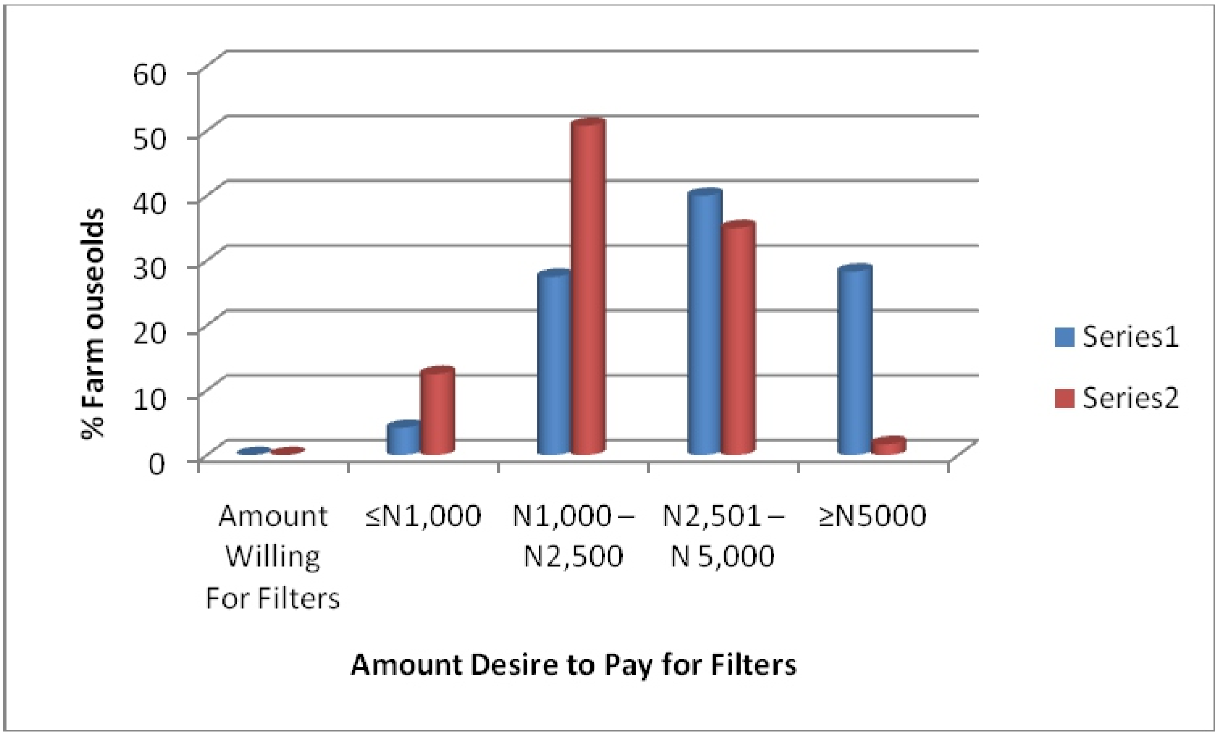

Figure 3: Amount Households are willing to Pay for Clay and Bio-sand Filter in the Study Area
***Note: Series 1 is Clay Filter**
Series 2 is Bio-sand Filter.

As shown in table 6, the determinants of preference for clay and bio-sand filter were analyzed using Tobit regression model. From the result, age of the respondents and level of education were significant at 1%. Age^2 was significant at 10%. From the table, there is positive relationship between the age of the respondents and their preference level for clay and bio-sand filter in the study area. A unit increase in the age of the respondents' will lead to 5.1% increase in the respondents' preference level for clay and bio-sand in the study area. According to World Health Organization (WHO), (2016) as people are growing old, they will be cautious of what they eat and the water they drink, hence they will tend to appreciate PoU water treatment systems such as clay and bio-sand filter.

Also, the more educated the respondents in the study area were, the higher their preference level for clay and bio-sand filter. As shown in table 6, a unit increase in educational level of the respondents will lead to 80.9% increase their preference level for clay and bio-sand filter in the study area. According to Fonyuy, (2014) education brings about awareness of danger of water related diseases such cholera, diarrhea and others. So the more educated respondents will desire PoU water treatment systems such as clay and bio-sand filter compare to the less educated respondents in the study area. A unit increase in the future age of the respondents would lead to 11.7% increase in their preference level for clay and bio-sand filter, age^2 has positive effects on the preference level of the respondents' in the study area. This shows that as respondents advance in age, their preference for PoU water treatment systems such as clay and bio-sand filter that are of health benefit tends to increase. This result conforms to the findings of Innocensia, (2013) who established that older people are more likely to prefer clay and bio-sand filter with high quality.

Table 6: Tobit Estimates of the Respondents' Preference for Clay and Bio-sand Filter

Variable	dy/dx
X_1 = Age	0.0051158 (3.39)***
X_2= Highest educational level of respondent	0.0809408 (6.14)***
X_3 = Household size	0.6196302 (1.27)
X_4 = Estimated monthly income	1.399644 (0.93)
X_5 = Employment status of respondent	0.0932046 (0.64)
X_6 = Age^2	0.1171042 (1.62)*
X_7 = Access to safe water	0.0012209 (1.89)
Constant	-3.817589 (-1.23)

*** Significant at 1%; ** Significant at 5%; * Significant at 10%;
Number of observations = 108   LR ch^2 (9) = 25.12   Prob > ch^2 = 0.0396
Log likelihood = -93.391019   z-ratios are in parenthesis

The result of the logit regression analysis in table 7 revealed that out of the eleven explanatory variables included in the regression model for willingness to pay for clay filter, eight variables were significant. The willingness to pay for clay filter was influenced by age of respondents, highest educational level of respondents, estimated monthly income, and employment status of respondents. Others include; habitation, awareness of clay filter, preference level of respondents and price of clay filter. While the willingness to pay for bio-sand was influenced by age of respondents, highest educational level of respondents, age^2, price of the bio-sand filter and awareness of bio-sand filter.

From the Table, a unit increase in the level of respondents' educational level tends to increase the willingness to pay for clay and bio-sand filter by 35.21% and 19.37% respectively in the study area. This implies that the more educated a respondent is, the more he/she will be willing to pay for the clay and bio-sand filter. This is in consonance with the findings of WHO (WHO, 2016) that educated people appreciates PoU water system because of the high value placed on hygienic water compare to the uneducated people who have little or no value for hygienic water due to lack of understanding of water borne diseases. A unit increase in the price of clay filter tends to increase the willingness to pay for the clay filter by approximately 0.22%, whereas a unit increase in the price of bio-sand will reduce the willingness to pay for the bio-sand filter by approximately 0.88% in the study area. This corroborate table that many respondents preferred the design and attributes of the clay filter compare to the bio-sand filter, hence they are willing to pay extra money for the design and attributes of the clay filter in the study area.

Again, the estimated monthly income of the respondents has a positive marginal effect of 6.3 x 10^9 on the clay filter in the study area. This implies that a unit increase in the monthly income of the respondents, will lead to a positive increase in their willingness to pay for the clay filter in the study area. People will be willing to pay for a PoU system such as clay filter that they perceived is beneficiary to them when their income increases. Equally, the employment status of the respondents in the study area was significant at 5% level for the clay filter. This indicates a positive marginal effect, meaning that the willingness to pay for clay filter by employed respondents increased by 23.0% in the study area. Probably because such respondents will be buoyant enough to pay for the clay filter.

The age of the respondents was positively significant at 5% level for the bio-sand filter and positively significant at 10% level of significance for the clay filter. This implies that the age of the respondents had a positive significant marginal effect on the respondents' willingness to pay for the clay and bio-sand filter in the study area. This implies that a year increase in the age of the respondents will increase their willingness to pay for clay filter by 3.56% and 4.96% for the bio-sand filter in the study area. This result shows that older respondents have higher probability of knowing and appreciating any system such as PoU system that will prevent water borne diseases (Coster and Otufale, 2014)**.** Hence older respondents will have positive attitude towards the clay and bio-sand filter, and will be willing to pay for the filters.

The respondents' awareness of clay and bio-sand filter was positively significant at 5% and 10% level of significance in the study area. This revealed that increase in the respondents' awareness of the filters will increase their willingness to pay for the clay and bio-sand filter in the study area. This is the effect of advertisement on a product; advertisement will reveal all the benefits of the filters. Therefore, increase in the awareness of the filters will definitely lead to marginal increase in the willingness to pay for clay filter by 3.23% and 18.96% for the clay and bio-sand filters in the study area. Respondents' preference level was positively significant at 5% level of significance for the clay filter in the study area. This implies that increase in the preference level of the clay filter based on the design, size, material, water volume and most especially water treatment would likely increase willingness to pay extra amount for the clay filter in the study area by 8.90%. This buttressed the findings of Miškolci, (2011) that consumers are willing to pay for a product with high preference level index based on its attributes. The age[2] of the respondents in the study area was positively significant at 5% level of significance for the bio-sand. This shows that as older respondents advanced in age, the more they are willing to pay for the bio-sand filter with marginal effect of 0.034%.

Table 7: Logit Estimates of Factors Determining Respondents' Willingness to Pay for Clay and Bio-sand Filter

	Clay filter	Bio sand filter
Variable	**dy/dx**	**dy/dx**
X_1 = Age of respondent	0.0356892 (1.79)*	0.0496585 (1.68)**
X_2 = Highest educational level of respondent	0.3521303 (2.45)***	0.1937 (7.35)***
X_3 = Household size	-0.0029592 (-027)	-0199709 (-1.11)
X_4 = Estimated monthly income	6.30e-09 (3.12)**	1.50e-06 (0.48)
X_5 = Employment status of respondent	0.2300102 (1.79)**	-0.499083 (-0.59)
X_6 = Age^2	0.0003922 (-1.41)	-0.003496 (-1.84)*
X_7 = Access to safe water	-0.17921 (1.65)	-0.2297101 (-1.39)
X_8 = Price of the clay filter	0.0021923 (10.97)***	0.8985248 (0.82)
X_9 = Price of the bio-sand filter	-0.0000198 (-028)	.-0.008790 (4.89)***
X_{10} = Awareness of clay/bio -sand filter	0.0323907 (2.31)**	0.1896861 (1.80)*
X_{11} = Preference level of respondents	0.0890809 (2.47)**	.0015915 (0.10)
Constant	-16.24907 (-2.98)**	-3.810132 (-0.79)

*** Significant at 1%; ** Significant at 5%; * Significant at 10%;

The z-ratios are in parentheses
Number of observations (Bio-sand filter) = 120
LR ch^2 (11) = 61.39
Prob > ch^2 = 0.0001
Log likelihood = -53.527819

Number of observations (Clay filter) = 120
LR ch^2 (11) = 101.72
Prob > ch^2 = 0.0004
Log likelihood = -62.992715

Conclusion and Recommendations

The survey revealed that most of the respondents in the study area were adults above the age of 40 years. The study revealed that 66.6% of the respondents in the study area had between 0 and 5 household sizes which enable us to test the effectiveness of the filters with respect to household demand for water in terms of volume. Also, the respondents in the study area were aware of water borne diseases, hence the need for Point of Use (PoU) system that can help to reduce the effects of water borne diseases in the study area. .The willingness to pay for clay filter was influenced by age of respondents, highest educational level of respondents, estimated monthly income, and employment status of respondents, awareness of clay filter, preference level of respondents and price of clay filter. The study therefore, recommends that bio-sand should be improved upon with respect to its design, size, material, water volume and treatment to make it acceptable like clay filter.

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