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Willingness to Pay for Biofuel Among Small-Scale Food Processors in Ibadan Metropolis, Nigeria

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ABSTRACT

Cooking takes the largest percentage of energy consumption and most households still depend on wood fuel energy, which contributes significantly to global warming. However, a major consideration for market infiltration of a green energy product is the willingness of consumers to pay for it. The study examined the determinants of willingness to pay for biofuel among small-scale food sellers in Ibadan metropolis. Primary data were collected from one hundred and fifty-five small-scale food sellers in Ibadan metropolis using a multi-stage sampling procedure. Data were analysed using descriptive statistics and probit regression. The majority of the food sellers were female (91.0%) with less than five household members (65.8%) and had tertiary education (40.0%). Most of them were not aware of biofuel (82.6%) but were willing to substitute firewood for biofuel (78.1%). The probability of willingness to pay for biofuel was increased by household size, being a female but reduced by bid at the unit price of ₦500 per litre. However, it was reduced by household size and education at ₦600 per litre. Based on the findings of this study, the entrepreneurs should take advantage of the emerging biofuel market by creating awareness of green energy and its benefits among the citizenry while government should support its production so that it can be sold at affordable price.

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Introduction

In rural areas, the main source of energy for cooking and heating water is biomass (solid-fuel) combustion, which is a major source of environmental and public health crisis across the globe (Sigsgaard, et al., 2015). Biomass has the potential to decrease agricultural productivity and leads to forest degradation, thereby contributing significantly to global warming (Bailis, et al., 2007). The current deforestation process observed in Africa derives, in part, from the abundance supply of wood, which is used for fuel by households. It is a known fact that in Africa, wood is the most affordable energy source for most households (Bechis, 2017; World Bank, 2014). However, owing to upsurge in population and the incessant rise in price alternative green energy sources, the demand for wood fuel has exceeded the supply, resulting in high level of deforestation in developing countries. Further, the release of particulate matter, carbon monoxide, and other harmful products of incomplete combustion from biomass cooking is strongly linked to chronic health problems (Dherani et al., 2008; Kurmi et al., 2010; Hosgood et al., 2014; and Bruce et al., 2015). The shift from traditional biomass use to modern energy efficient technologies has the potential to assuage numerous health, socio-economic and environmental problems (Tsephel et al., 2009).

Despite these negative effects, more than 700 million Africans (82%) depend primarily on solid fuels for their cooking needs while only few African households (11%) use clean energy sources, that run on modern fuels, as their primary cooking appliances (World Bank, 2014). Further, access by poorer and rural communities to modern, clean fuel is currently limited by relatively high prices, low demand and unreliable supply (Price, 2017). However, most initiatives on renewable energy are concentrated on electricity generation while about two-thirds of the world energy consumption is derived from fossil fuel (Hankamer et al., 2007). Although there has been a decline in the number of people that use biomass for cooking purpose, there is a rising number of people relying on biomass in Africa where most rural households rely on wood fuel (Roth, 2014). Stoves that run on such renewable energy as biofuel and solar are less common (less than 1%) (World Bank, 2014).

A majority of poor Nigerian population largely rely on energy from renewable sources and primary biomass such as fuelwood, charcoal, palm kernel shells, palm-oil wastes (shaft and slurry), sawmill waste, among others (Abila, 2011). The over-dependence on fuel wood for energy is mainly owing to its relatively low prices and easy

accessibility, constraints in the supply of the conventional fuels and the growing population with a larger segment still falling below incomes that cannot afford the cost of conventional fuels (Adedayo, 2005; Adedayo et al., 2008). Though there is also a rapid growth of urban centers across the country, the majority of the urban population depend on these renewable sources such as charcoal because of the very low rate of access to electricity, natural gas or other improved energy sources (Abila, 2011). For most Nigerians, cooking is the most important energy requirement of the family and about 71% of the population depends on firewood for cooking using traditional three-stone fires (NBS, 2016). Owing to insufficient energy delivery infrastructure to handle the nation's energy demand, with just 40% of homes in Nigeria having access to hydroelectricity, the country is in a deep energy predicament (Oyedepo, 2012; Garba and Kishk, 2014). This presents a gloomy picture of environmental sustainability in the continent which calls for policy shifts to enhance environmental sustainability and reduce deforestation, through a switch to environmentally-friendly clean liquid fuel alternatives.

One of these clean energy sources is biofuel produced from non-edible feedstock's, which reduces direct competition with food production (UNCTAD, 2008). In order to ensure a significant decline in carbon emissions, it is important to expand the biofuel energy market. However, a major consideration for market infiltration of any product is the assessment of the public's willingness of consumers to pay for its consumption and attitude towards its consumption (Farrow et al., 2011; Akinwale et al., 2014). Attitudes is a pre-disposing factor to environmental behavior (Birgelen et al., 2009), although its effect is relatively weak (Fraj and Martinez, 2007). The limited availability and high price of fuel are major disincentives to the use of biofuel (Collantes, 2010). Furthermore, the most commonly reported socio-economic factors influencing willingness to pay for biofuel are age, income, education, household size, and gender (Heltberg, 2005; Ouedraogo, 2006; Jensen et al., 2012).

Biomass remains the most dominant energy not only for the household sector but also for the small-scale industries and commercial outlets in Nigeria (Sa'ad and Bugaje, 2016). Burning of fuel-wood by food processors is seen to be the most observed method used by food processors for their processing activities and also releases a significant amount of carbon dioxide in to the environment (Phillip and William 2004). Owing to a dearth of empirical socio-economic studies on willingness to pay for biofuel energy for cooking in Nigeria, the determinants of small-scale food processors' willingness to pay for biofuel was therefore assessed in this article.

Materials and Methods

Ibadan is the largest city in Nigeria. It also houses several educational institutions such as the premier university in Nigeria (University of Ibadan), University College Hospital (College of Medicine), The Polytechnic Ibadan and several private and public secondary and primary schools. The population for the study consisted of all small-scale food processors (cooked food sellers) with not more than five workers in Ibadan North Local Government Area. Data was collected in 2017 from small-scale food processors (cooked food sellers) using a multi-stage random procedure. The first stage was the random selection of Ibadan North Local Government Area (LGA) while the second stage was the random selection of four wards out of the twelve wards in the LGA. A sample of one hundred and fifty-five respondents were drawn using random sampling from the four (4) wards proportionate to size. Information was collected from the small-scale food processors on their socioeconomic characteristics, attitude towards greenhouse gas emission, and willingness to pay for biofuel. Secondary sources of information like journals, textbooks, working papers, reports and the internet were also used for literature review, methodology and descriptions of results. Contingent valuation method which sets bid price and establish if food processor would be willing to buy biofuel at that price was used.

Descriptive statistics were used to profile the socio-economic characteristics of respondents. Probit model was used to explain dichotomous decision by set of variables relating to household characteristics and bid price. Also, the Mean Willingness to Pay was calculated using Haenemann's model (1980). This study used probit regression analysis to identify the various factors that can affect respondents' willingness to pay for renewable energy.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta n Xn + \varepsilon$$

Where:
Y = dependent variable
β_0 = constant intercept
$\beta_1 - \beta n$ = parameter estimates (coefficients)
$X_1 - Xn$ = independent variables
ε = error term

Probit regression model was used to estimate the willingness of respondents to pay for biofuel at the current market price per liter (five hundred naira) and a 20% increase in current price (six hundred naira). Mean willingness to pay at these price levels was estimated using Hanemann and Kanninen (1998),

$$\text{Mean WTP} = \frac{1}{\beta_1^*} \ln\left(1 + \exp\beta_0\right)$$

Where:
β_1= regression coefficient of bid
B_0= constant term

Results and Discussion

Socio-economic factors are useful for identifying the target market for biofuel and for understanding the characteristics of the market and its consumers. The socioeconomic characteristics of the respondents were analysed using descriptive statistics. These include the characteristics related to personal information about the respondents, their awareness status about greenhouse gas emission and those related to their willingness to pay for renewable energy technology. Most of the food sellers were female (91.0%) while only (9.0%) of them were male (Figure 1) indicating that food-selling is a female-

dominated livelihood activity in the area. This is possibly because of the traditionally construed role of domestic cooking for women in Africa.

Similarly, a larger percentage (83.2%) of the respondents were married while only 5.8% of them were single (Figure 2). This suggests that they might want to be frugal and spend less on energy in order to increase their household per capita income.

The highest proportion (52.3%) of the respondents were within the age bracket of 41-50 years while the least percentage (5.8%) of the respondents were between the age-group of less than 30 years old (Table 1). A typical small-scale food seller was 42.47 ± 6.66 years old (Appendix). This implies that most of the respondents were in their economically active years, which could positively influence their willingness to pay for renewable energy. Furthermore, two out of every five food seller (40.0%) had tertiary education while only 2.6% had no formal education. They also had an average of 11 years of formal education (Appendix). This suggests that most of them may not know the effects of solid-fuel combustion and the benefits of using clean energy on the environment. Small household size may positively influence willingness to pay for renewable energy. Most of the respondents (65.8%) had small household sizes (less than five members) while only 1.9% of them had above ten household members. The food processors earned an average monthly income of N36, 474.03 ($1,000) (Appendix). However, one out of five food sellers earned above the middle-income group (> ₦30,000.00 - ₦40,000.00). Owing to low income, most of the food processors may not be able to afford clean energy stoves and consequently not willing to pay for renewable energy since they can afford it from their monthly income.

The respondents strongly agreed that burning of firewood causes health problems (74.2%; $\bar{x}$ = 4.66) and that it pollutes the air we breathe in (68.3%; $\bar{x}$ = 4.65) (Table 2 and Figure 3). They agreed that burning of charcoal causes health problems (32.9%; $\bar{x}$ = 3.6). Similarly, 51.0% of the respondents agreed that burning of firewood causes increase in environmental temperature (51.0%; $\bar{x}$ = 4.40) and pollute water bodies (48.4%; $\bar{x}$ = 4.19). About 62.6% of the respondents also agreed that burning of firewood causes heart and lung ailments (62.6%; $\bar{x}$ = 3.65) and increases in land desertification (46.5%; $\bar{x}$ = 3.76). However, they were undecided on the fact that burning of firewood also causes flooding (52.90%; $\bar{x}$ = 1.85). The respondents had a fair knowledge ($\bar{x}$ = 3.98) of effects of wood fuel combustion on the environment and their health.

Most of the respondents (71.0%) used wood-fuel energy (firewood and charcoal) while 23.2% of them used hydro-electric alternative energy sources (electric cooking devices) (Table 3). This suggests that wood fuel combustion is still the major cooking energy source among food processors in urban areas and may contribute significantly to high level of air pollution in the cities. The food processors also had an average of N6, 024.211 monthly expenditure on cooking energy (Appendix) and 69.2% of them did not spend above the mean value (Table 3). Most of the respondents (82.6%) were not aware of biofuel stove which suggested the need to create more awareness about the benefits of using biofuel stove among the food sellers.

Most food processors (98.1%) were aware of methane gas for cooking and were ready to substitute wood fuel for the clean energy (Figure 4). However, owing to a low level of awareness of biofuel stoves among the food processors, 78.1% of them were willing to substitute firewood for biofuel. This shows that majority of the respondents will like to substitute firewood for alternative clean energy sources.

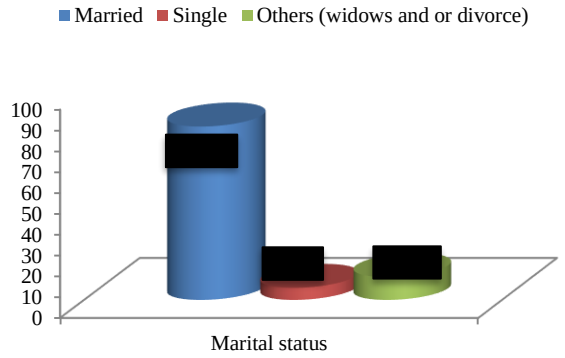

Figure 1. Distribution of respondents by marital status

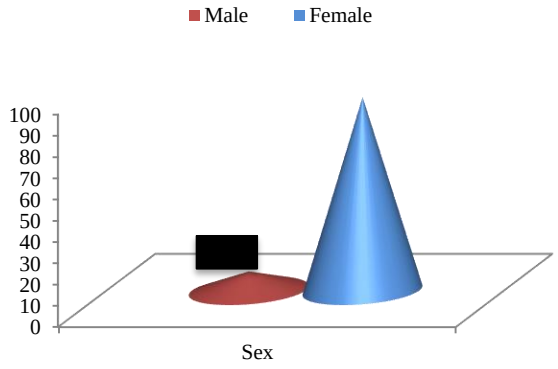

Figure 2. Distribution of respondents by gender

Table 1. Distribution of respondents socio-economic characteristics (N=155)

Socio-economic characteristics	Frequency	%
Age (years)		
0 – 30	9	5.8
31 – 40	49	31.6
41 – 50	81	52.3
51 – 60	16	10.3
Educational level		
No formal education	4	2.6
Primary	34	21.9
Secondary	55	35.5
Tertiary	62	40.0
Household size		
0 – 4	102	65.8
5 – 9	50	32.3
10 and above	3	1.9
Monthly income		
≤₦20,000.00	38	24.3
₦20,001.00- ₦30,000.00	36	22.4
₦30.001.00- ₦40,000.00	48	30.7
₦40,001.00- ₦45,000.00	6	3.8
>₦45,000.00	27	17.7

Table 2. Likert Analysis of respondents' perception about firewood

Q	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Weighted score
1	115 (74.19)	31(20.00)	5 (3.23)	4(2.58)	0 (0.00)	722
2	42 (27.10)	51(32.90)	23 (14.84)	38 (24.52)	1(0.65)	559
3	106(68.39)	46 (26.68)	1(0.6)	2(1.29)	0(0.00)	721
4	79 (50.97)	68(43.87)	5(3.23)	3(1.94)	0(0.00)	682
5	7(4.52)	38(24.52)	82(52.90)	27 (17.42)	1(0.65)	447
6	14 (9.03)	97 (62.58)	37 (23.87)	7(4.52)	0(0.00)	583
7	16 (10.32)	72 (46.45)	64 (41.29)	3 (1.94)	0(0.00)	566
8	58 (37.41)	75 (48.39)	15 (9.68)	7 (4.52)	0 (0.00)	649

1: The use of firewood causes health problems,
2: The use of charcoal causes health problems,
3: The use of firewood pollutes the air we breathe in
4: The use of firewood causes increase in environmental temperature
5: The use of firewood also causes flooding
6: The use of firewood causes increase in desert land
7: The use of firewood can cause heart and lung ailments
8: The use of firewood can pollute our water

Q: Questions, Overall Weighted Average = 3.98**, Figures in parentheses are percentages

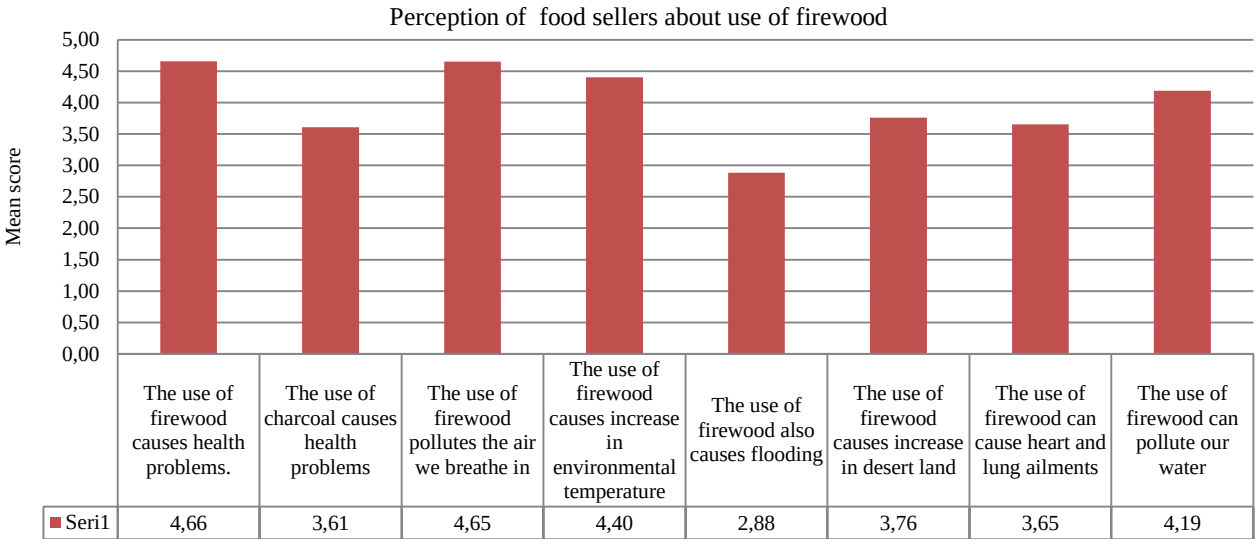

Figure 3. Perception of food sellers about firewood

Decision Value: (mean weighted average for low perception = <3.5; mean weighted average for high perception = ≥3.5)

Table 3. Distribution of respondents according to energy source used

	Frequency	%
Source of energy		
Conventional Firewood	72	46.5
Charcoal	38	24.5
Gas cooker	45	29.0
Total	155	100.0
Renewable		
Solar power	4	10.0
Electric pot	21	52.5
Electric kettle	14	35.0
Electric oven	1	2.5
Cost of energy used		
Less than ₦3,001.00	29	18.6
₦3,001.00 - ₦6,000.00	79	50.6
₦6,001.00 - ₦9,000.00	35	22.4
₦9,001.00 - ₦12,000.00	9	5.8
₦12,001.00 - ₦15,000.00	3	1.9
Awareness of biofuel stove		
Yes	27	17.4
No	128	82.6
Willingness to pay 5litres of biofuel for N2, 500		
Yes	36	23.2
No	119	76.8
Willingness to pay 5litres of biofuel for N3, 000		
Yes	13	8.4
No	142	91.6

Table 4. Determinants of willingness to pay for biofuel per litre at the current market price ₦500.00 per litre

Variables	Main Effect		Marginal effect	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.0183	0.0208	0.0050	0.0056
Household size	-0.2560	0.11245**	-0.0699	0 .0309
Education	0.0241	0.0304	0.0066	0.0082
Being a female	0.7229*	0.4356	0.2419	0.1662
Monthly income	0.4260	0.3429	0.1163	0.0933
Marital status	-0.0314	0.3745	-0.0085	0.1003
Bid	-1.0902	0.3052***	-0.2975	0.0806***
Constant	5.1195	3.4664		

LR chl2 (7) = 30.16, Prob> chi2 = 0.0001, Pseudo R2 = 0.1844, Note: *, ** and *** implies significant at 10%, 5% and 1% respectively

Table 5. Determinants of willingness to pay for biofuel per litre at ₦600.00

Variables	Main Effect		Marginal effect	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.0220	0.0208	0.0025	0.0032
Household size	-0.2937**	0.1332	-0.0329**	0 .0152
Education	0.0912*	0.0499	0.0102*	0.0053
Being a female	0.6787	0.5182	0.1165	0.1236
Monthly income	0.3501	0.4462	0.0392	0.0495
Marital status	-0.4058	0.4766	0.0561	0.0785
Bid	-0.1686	0.3677	-0.0189	0.0412
Constant	-0.2079	4.4669		

LR chl2 (7) =12.53, Prob> chi2 = 0.0844, Pseudo R2 = 0.1495, Note: *, ** and *** implies significant at 10%, 5% and 1% respectively

Determinants of Willingness to Pay for Biofuel at The Current Market Price (₦500.00/ Liter)

The probability of urban food sellers' willingness to pay for biofuel at a cost of ₦500 per liter had an inverse relationship with the cost of biofuel stove and their household sizes but it had a positive relationship with being a female food processor (Table 4). Therefore, a unit increase in the bid reduces the willingness of respondents to pay for biofuel at ₦500 by 0.2975 unit. Similarly, an additional household member would decrease their probability of willingness to pay for biofuel at ₦500 per liter by 0.0699 unit. However, female food processors were more probable to pay for biofuel at ₦500 per liter than their male counterparts. Using Hanemann (1989) model, the mean willingness to pay at a price of ₦500 can be calculated as:

$$\text{Mean willingness to pay} = 1/1.0902 \times \text{In}(1+\exp^{5.1195})$$
$$0.917262887 \times 5.125483077 = ₦470.15$$

The mean willingness of respondents to pay for biofuel per litre was ₦470.15

Determinants of Willingness to Pay for Biofuel Per Litre at 20 Percent Increase in Current Market Price (₦600/Litre)

Household size had negative effect while years of formal education had a positive effect on the respondents' willingness to pay at ₦600 per litre of biofuel (Table 5), similar to the observation in Table 4. Thus, households with smaller size and highly educated members would be more willing to pay for biofuel than those with large household sizes with fewer years of formal education. An additional household member would reduce the probability of willingness to pay for biofuel at ₦600 by 0.0329 unit while an additional year of formal education would increase it by 0.0102 unit. Using Hanemann (1989) model, the mean willingness to pay at a price of ₦600 can be calculated as:

$$\text{Mean willingness to pay} = 1/-0.1686 \times \text{In}(1+\exp^{0.2079})$$
$$5.931198102 \times 0.802490279 = ₦475.97$$

The mean willingness of respondents to pay for biofuel per liter is ₦475.97

Conclusion

A majority of the poor Nigerian population largely rely on energy from biomass for fuel with negative consequences on the environment and human health. Thus the need to adopt green energy products that are environmentally friendly. The study examined the determinants of willingness to pay for biofuel among small scale food processors in Ibadan metropolis. The results from the socioeconomic characteristics showed that small-scale food processing is a female-dominated livelihood activity. The most frequently used source of energy by the respondents is firewood of about (46.5%) implying that wood fuel combustion is still the major cooking energy source among food processors in urban areas and may contribute significantly to high level of air pollution in the cities Most of the respondents (82.6%) were not aware of biofuel stove, suggesting the need to increased awareness about the benefits of using biofuel stove among the food sellers. The respondents strongly agreed that burning of firewood causes health problems and pollutes the air we breathe in. They also agreed that burning of charcoal causes health problems, increase in environmental temperature and pollute water bodies. This implies a good

perception of negative consequences of burning biomass on the environment.

Although, a good perception of effects of solid fuel burning on the environment but the majority of them were not aware of biofuel stove. Willingness to pay for biofuel was explained by household size, being a female food processor, bid and education. Thus, private entrepreneurs should seize the opportunity of the large market in urban areas by creating awareness about the effect of greenhouse gas emission on man and the environment. This will create market and employment and clean environment. The government should also increase friendly investment climate that will ensure low cost of production of clean energy production that will ensure that biofuel is readily available and accessible in the market at affordable prices.

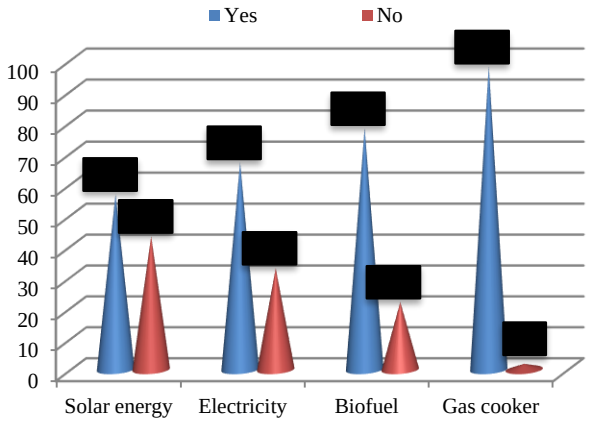

Figure 4. Substitution of wood fuel for clean sources

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