ASSESSING THE SUSTAINABILITY OF RENEWABLE ENERGY EXPLOITATION AND UTILIZATION AMONG RURAL HOUSEHOLDS IN SOUTHWEST NIGERIA

Kolawole A. O.[1*] and Sekumade A. B.[2]

[1,2] Ekiti State University, Department of Agricultural Economics and Extension Services

**Corresponding Author: ayotunde.kolawole@eksu.edu.ng*

+234-8034965672

Abstract

Rural households' access to different energy sources is crucial to achieving sustainable development. The focal point of this study was to analyze the correlation between factors influencing the quantity of fuel wood utilized and amount spent on fuel wood by rural households. The Sources of energy resources utilized by rural households and environmental activities associated with forest resource exploitation were also examined. Descriptive Statistics and a Two Stage Least Square (2SLS) models were used to analyze survey data from 225 households. The results showed that the majority of the respondents (87.1%) which were female and married (70.7%) subsist on biomass and kerosene to meeting their energy needs. Household size and income were the most significant variable ($p < 0.001$) influencing the average quantity of fuel wood utilized vis-à-vis the amount spent on fuel wood consumption. The amount spent on fuel wood being insignificant does not truly reflect its consumption pattern as the instrumental variables in the 2SLS didn't collinear. The entire exogenous variables aside the amount spent on substitutes and transportation costs were significant. The household size had a positive effect on the quantity of fuel wood consumed while the amount spent on substitutes was inversely related to the quantity of fuel wood consumed. Eight-six percent of the respondents engaged in bush burning while 90 percent engaged in deforestation. An average of 324.3kg of fuel wood was exploited freely annually as efforts were not made to replace lost biomass. The study recommends intensive agroforestry for reforestation. Also, the Government, Non-Governmental Organizations and well to do private/individuals should support the provision of technology incentives like energy saving firewood and improved stoves while subsidizing fossils fuel prices for energy shift among rural households.

Keywords: Forest and non-forest resources, 2SLS, rural households and Nigeria.

Introduction

Globally, more than 3 billion (nearly half of world human) are deprived of access to modern energy alternatives (Dawit, 2012) that are environmentally friendly. Renewable energy comes from resources which are continually replenished on a human scale (Wikipedia, 2013). They are inexhaustible by use over time and can be regenerated. This include biomass (fuelwood), solar, hydropower, wind, geothermal, biofuel and hydrogen. According to Mashauri (2011), the sources of renewable energy can be divided according to their origin. It could be natural renewable sources; which include wind, solar, geothermal etc. and renewable sources resulting from human activity, which is known as biomass. The later represents the largest potentially renewable source of energy in use in the world today (Kammen, 2001).

Most rural households in developing countries have less access to energy sources and essentially depend on traditional fuel (Nabinta, Yahya and Olajide, 2007). The increasing world population has led to a tremendous rise in the

demand for living space, food and energy (Fakayode, Animashaun, Babatunde and Salau, 2013). The supply and demand disequilibrium of renewable energy sources now constitutes a global threat to commerce, industries and livelihood security of the rural communities. This has led to serious environmental problems such as deforestation, soil erosion, grassland degradation, and desertification. Others are human diseases and loss of time for education, recreation, and even farming (Nabinta *et al*. 2007).

In the same vein, forest loss in Africa is particularly worrisome as two-third of the continent's population depends on forest resources for income and food supplementation, and 90 percent Africans use fuelwood and charcoal as sources of energy (Baofo, 2013). It shouldn't be surprising if traditional energy sources soon become non-renewable as fossil fuels, coal and natural gas may inevitably run out in the near future (Nwofe, 2013). This depletion of forest resources has a devastating effect on the ecosystem, causing pollution, deep and extensive damage to earth's crust, ozone layer depletion, global warming, destruction of vegetation and wildlife (deforestation and extinction).

Fuelwood exploitation goes unabated in rural areas of Nigeria, and seems not to be concerned about its adverse effect on the environment. It has long been recognized by the International Union for the Conservation of nature that the sustainability of the environment is best served when the interests of the rural communities who uses these renewable energy resources are taken into consideration (FAO, 2013). In line with the Millennium development Goal 7 (MDG) which is "to ensure environmental sustainability", a study of this is very germane. The multifaceted challenges of the exploitation of natural energy resources and its resultant effect on the environment have prompted the assessment of the sustainability of renewable energy exploitation and utilization among rural households in Southwest Nigeria. The specific objectives are, to:

i. explicitly describe the socio-economic characteristics of rural households in relation to energy use in southwest Nigeria,
ii. identify the energy sources utilized among rural households,
iii. analyze the existence of correlation between factors influencing fuelwood utilization and the actual cost of consumption among rural households,
iv. highlight the threats and challenges posed by present energy used among rural households in Nigeria.

Methodology

The research work was carried out in southwest geographical area of Nigeria. The area has a total land of 80,012.55km^2 and population of 26,742,465 (NPC 2006). Both the forest and savannah zones are peculiar to this area of Nigeria. Forested land occupies about 14 percent of the total land area in Nigeria. Her natural resources include petroleum, tin, columbite, iron ore, coal, limestone, lead, zinc, natural gas, hydropower, and arable land (Wikipedia, 2013, 2014).

A multi-stage sampling technique was employed to draw the sample for the survey. First, three (3) states were randomly selected; followed by the random selection of three (3) Local Government Areas (LGA) and the third stage involves the random sampling of five (5) communities from each LGA. The final stage involves the random sampling of five (5) rural households. This equal order of selection was to ensure equal representation and to reduce biases. In aggregate, 225 households were selected and interviewed through the aid of a well-structured questionnaire. Data were sought on rural household's socio-economic and demographic characteristics, sources of energy utilized and environmental activities of rural households in the study area.

Descriptive statistics (frequency table and charts) and a Two-Stage Least Squares (2SLS) method were employed to achieve the objectives of the study. In a 2SLS method, a simultaneous equation model was appropriate because of a *simultaneity problem* arising from correlation relationship between the quantity of biomass utilized by rural households and its price against other influencing factors (Gujarati, 2006 and Koutsoyiannis, 2001).

The simultaneous linear equation is stated below;

$$Y_{1t} = A_1 + A_2Y_{2t} + A_3Y_{1t} + U_{1t} \ldots\ldots (1)$$

$$Y_{2t} = B_1 + B_2Y_{1t} + B_3X_{2t} + U_{2t} \ldots\ldots (2)$$

Y_{1t} = Average Quantity of Fuel wood Utilized (Kilogram)

Y_{2t} = Amount Spent on Fuel wood (Naira)

In decomposing the linear equation above, we take the logarithm of both sides since they are unlike terms;

$$lnY_1 = \alpha o + \alpha_1 lnX_1 + \alpha_2 lnX_2 + \alpha_3 lnX_3 + \alpha_4 lnY_2 + \alpha_5 lnX_5 + U_1 \ldots\ldots (3)$$

$$lnY_2 = \beta o + \beta_1 ln\ddot{Y}_1 + \beta_2 lnX_5 + U_2 \ldots\ldots (4)$$

Where

Y_1 = Average Quantity of Fuel wood Utilized by Households (Kilogram).

X_1 = Household size (Number).

X_2 = Monthly income of the household (Naira).

X_3 = Distance from home to the source of fuel wood (Kilometre).

Y_2 = Amount spent on fuel wood (Naira)

X_4 = Amount spent on substitutes (Naira)

X_5 = Transportation cost (Naira)

$\ddot{Y}_1$ = Estimated values of Y using the linear form in equation (1).

α_1 = coefficients of the main (quantity of fuel wood utilized) equation.

β_i = coefficients of instrumental variables (from equation 2)

μ_i = Stochastic error terms.

ln = exponential log to base *e*.

Results and Discussion

Socioeconomic Characteristics of Respondents in Relation to Energy Utilization

From Table 1, there were younger people (53.8%) in the study area and only 17.3% of the respondents were above 60 years of age. The implication of their mean age (39.5years) shows that the majority of the rural households in the study area were still in their active age. Most studies on rural households' energy utilization (Ikurekong, Esin, and Mba, 2009; Nabintal *et al.*, 2007; Fakayode *et al.*, 2013) didn't consider age as a factor for utilizing different energy sources for domestic use. This assertion was not true about studies that focused on forest energy options like firewood, charcoals, etc. (Preston, 2012; Beyene, 2010) that respondents in their active ages have the strength to gather more fuelwood for domestic use. This could conform to *apriori expectation*, but studies like that of Onyeneke, Nwajiuba, and Nwosu (2015) contradicts the significance of this finding, that older collectors consume more of fuelwood than younger collectors. This could be that older collectors have more responsibilities to their households that could require the use of more fuelwood than the younger collectors (Onyeneke *et al.*, 2015). Majority (87.1%) of the sample for the survey were female (Table 1). This result is expected since the major domestic energy utilization purposes like cooking and heating are usually carried out by women. Mwangi (2013) asserts that females were actively involved in the searching and gathering of fuelwood to meet their household energy demand. These findings contradict that of Fakayode *et al.* (2013) which reported the majority of their respondents (86.7%) to be male in their study on determinants of forest resources uses and its

implications for environmental sustainability in Nigeria. About 70.7percent of the samples were married. The implication of these results is that married respondents will consume more of forest or non-forest energy resources to meet their domestic energy purposes. Also, 36.9percent of the respondents have primary education, 46.2percent have secondary education and 13.3percent have post-secondary education, while only 3.6percent didn't acquire any formal training (Table 1). The implication of education may prompt household members to be more energy efficient (i.e. using improved cooking technologies) than respondents that are not educated. Likewise, the respondents with no educational attainment may be the best user of biomass for energy utilization. The result contradicts that of Fakayode *et al*. (2013) that about half (45%) of the households interviewed in their study have no form of formal education while more than half of them (55.5%) have had the basic primary education. The study of Nabinta *et al*. (2007) reasonably conforms to this study as 78.7percent have one form of education. More than half (55.1%) of the respondents in the study area had household size of 4 and 6. The mean household size of the respondents was 6 persons. It implies that larger household will have higher energy consumption compared to their small households' counterparts. Apart from the reason that such households would demand more fuelwood or alternative energy sources for cooking or heating, the high consumption may be explained by the fact that such households had more persons available to collect firewood (Mwangi, 2013) which is the major (40%) biomass used in the study area. 42.7 percent of the respondents in the study area practice Islam, while 40.9 percent were Christians. 16.4 percent opined that they were traditional worshippers. This implies that religion does not depict the type of energy options utilized by rural household. There has been no study that reported religion discrimination against the use of forest and non-forest resources for energy utilization in the study area.

The kind of apartment that the household lived in can determine the choice of energy resources used for meeting their domestic needs. This ranges from thatch/hut, mud block house and brick houses. The majority of the respondents (72%) lived in mud-block, 20 percent lived in thatch/hut and only 8 percent lived in the brick houses (Table 1). Candidly, the mode of house doesn't hinder the use of different sources of energy if the respondents own the apartments. According to Stephane, Serge and Arnand (2006) study on energy choices and fuel wood consumption, that if the household lived in an apartment rather than a house, the probability of choosing fuelwood decreases when compared to consuming none. The marginal effect was stronger (in absolute value) for use as back-up heating. Also, if the apartments had a main gas connection, the tendency of using fuelwood may decline, but there is hardly a gas connector in rural areas let alone the urban region of southwest Nigeria. The mean monthly income (^29,889.4) implies that majority of the respondents earn above the monthly minimum wage. About 20 percent of the respondents earn below the minimum wage in Nigeria. Studies by Nabinta *et al*. (2007) revealed a very low monthly income of respondents in Gombe state as the range of all their respondents' earnings was between ^1000 and ^5000. The households with higher income may climb the energy pyramid of affording non-forest energy resources like kerosene, gas, solar etc. but there will continue to be an increasing pressure on biomass for households with meager income. This study also conforms to that of Adepoju, Oyekale, and Aromolaran (2012) whereby average households' monthly income was about ^30,000.

According to the Nigerian energy policy report from 2003, it is estimated that the population connected to the grid system is short of the power supply over 60 percent of the time (Okoye, 2007). Nigeria is located on the west coast of Africa and having the highest population in Africa have less than 40 percent

of her population connected to the power grid. On a fundamental level, there is simply not enough electricity generated to support the entire population (Julia, Nick, Kyle and Allison, 2008). So also, the majority of respondents (69.8%) in rural areas of southwest Nigeria have no access to the power grid or rural electrification (Table 1). About one-third of the population sample in the study area had access to the power grid. The implication of this is that electricity may not be used as an alternative source of meeting their energy needs in the study area. Thus, there will likely be more pressure on natural resource energy supply. This has led to intense exploitation of fuelwood as about 63.3 percent of the respondents sourced for free fuelwood from other people's land (Table 1). They go to community lands, reserved land owned by the government and the non-governmental organization and the forest areas owned by others for fuel wood. Only 46.7 percent of respondents had personal land where they tap free fuelwood to meeting their energy need. A study by Alemu (1997) made a similar assertion that household collects woody biomass from two main sources; private sources and communal areas. Those who had trees did part or all of the collections from their own property partly because these private sources are usually close to the household homestead and the search time is lower even if they were at some distance from their homestead. The collection time from the private sources per unit of biomass fuel was lower than that of the communal areas.

Table 1: Socio-economic Characteristics of Rural Households

Variables	Frequency	Percentage	Mean
Age (year)			
1 – 20	42	18.7	
21 – 40	79	35.1	39.5
41 – 60	65	28.9	
> 60	39	17.3	
Gender (dummy)			
Male (1)	29	12.9	
Female (0)	196	87.1	
Marital Status (dummy)			
Single (0)	66	29.3	
Married (1)	159	70.7	
Education (years)			
0	8	3.6	
1 – 6	83	36.9	
7 – 12	104	46.2	7.75
> 12	30	13.3	
Household Size			
1 – 3	30	13.3	
4 – 6	124	55.1	
7 – 9	40	17.8	6.17
10 – 12	15	6.7	
> 12	16	7.1	
Religion (dummy)			
Traditional (1)	37	16.4	
Islam (2)	96	42.7	
Christianity (3)	92	40.9	
Mode/Type of House (dummy)			
Thatch / Hut (1)	45	20	
Mud-block (2)	162	72	

Brick (3)	18	8	
Monthly Income (₦)			
1 – 10000	2	2	
10001 – 20000	42	42	
20001 – 30000	82	82	29889.4
30001 – 40000	62	62	
40001 – 50000	17	17	
> 50000	20	20	
Access to Power Grid (dummy)			
Yes (1)	68	30.2	
No (0)	157	69.8	
Sources of Fuelwood (dummy)			
Personal / Own Land	105	46.7	
Community Land	63	28	
Government Land (Reserves)	37	16.4	
Non-governmental Land	13	5.8	
Forest Area Own by Others	7	3.1	

Source: Field Survey, 2016

Figure 1 showed the distribution of a free quantity of fuelwood gathered for consumption per annum. The average quantity gathered in the study area was 324kg. The vegetation is continually under a big loss of 324.3kg of biomass gathered for consumption (Fig. 2 & 3). The earth core will be posed with the danger of ozone layer depletion and global warming. These are the indicators of the negative effects of climate change in the environment. A similar finding by Ojo and chuffer (2013) showed that 401.5kg of fuelwood is consumed by rural household in Damboa Local Government Area of Borno State per annum. This implies that the average consumption of fuelwood per household per day was 6.6kg.

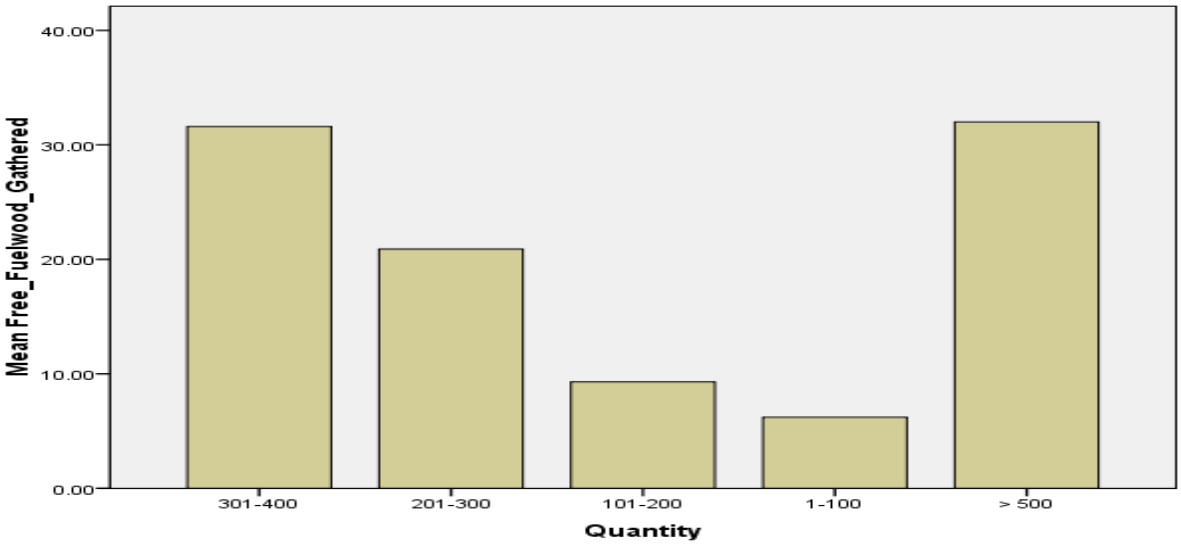

Figure 1: Quantity of fuelwood gathered per annum (Field Survey, 2016)

Figure 2: Evidence of deforestation in the study area (Field Survey, 2016).

Photo credit: Kolawole Ayotunde

Figure 3: Fuelwood gathered for household use in the study area (Field Survey, 2016)

Photo credit: Kolawole Ayotunde

About 61 percent of the respondents in the study area usually covered a distance between 1 and 3 km before having access to fuelwood while 13.3 percent of the respondents moved beyond 3 km to access fuel wood (Fig. 4). The implication of this findings is simply that the nearer the respondents to the sources of fuel wood, the lower the cost incurred and the more will be the fuel wood consumed.

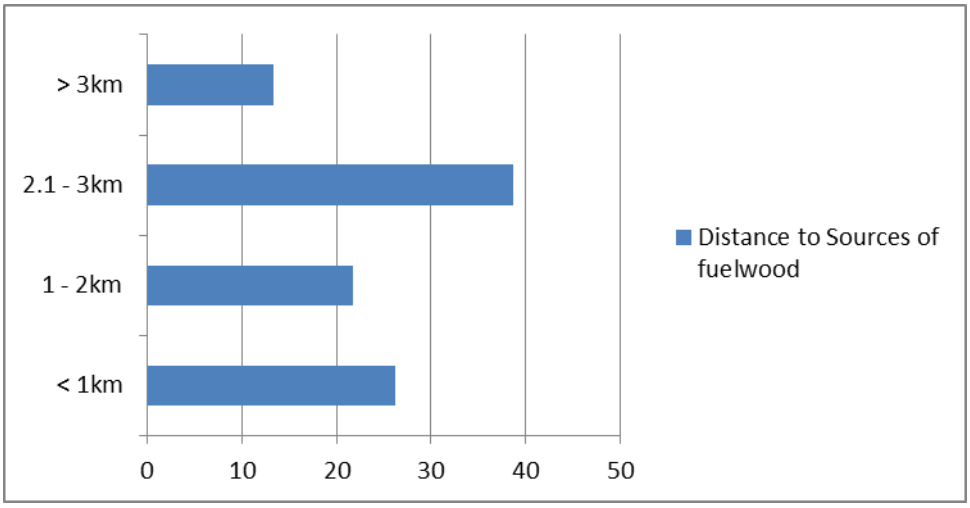

Figure 4: Distance to Fuelwood Sources (Field Survey, 2016)

Energy Sources Utilized by Rural Households

Forest Resources Utilized for Domestic Energy Purpose

Forty percent of the respondents in southwest Nigeria utilized firewood as their major source of domestic energy (Fig. 5). In the same vein, charcoal consumption takes precedence as 34.7 percent respondents utilized charcoal as their main energy option. From fig. 5, the dominance of firewood and charcoal as a major source of energy (74.7 percent) conforms with the studies of (Mwangi, 2013., Adepoju *et al.*, 2012, Nabinta *et al.*, 2007) that these sources of energy have been a traditional source and will still remain popular despite the fact that the supplies are dwindling (Mwangi, 2013). A few respondents utilized sawdust (16.4 percent) for energy purposes. Since fuelwood/biomass is a combination of both firewood, charcoal, sawdust and forest residues, it can be indirectly stated that the majority (96%) of the rural households in Southwest Nigeria still subsist on fuelwood as their main source of energy. The result may not apply to certain rural areas in Nigeria where there is no vegetation or where there is a relative comparative disadvantage for biomass growth. An example of such is the core Niger Delta regions where there are crude oil explorations and mining sites. Only 4 percent of the entire sample did not use forest resources for domestic energy purposes. This category of people could be elite in rural areas or mobile government workers whose income doesn't make them fit into this vicious cycle of energy poverty. Thus, they prefer to utilize non-forest energy sources like kerosene and gas.

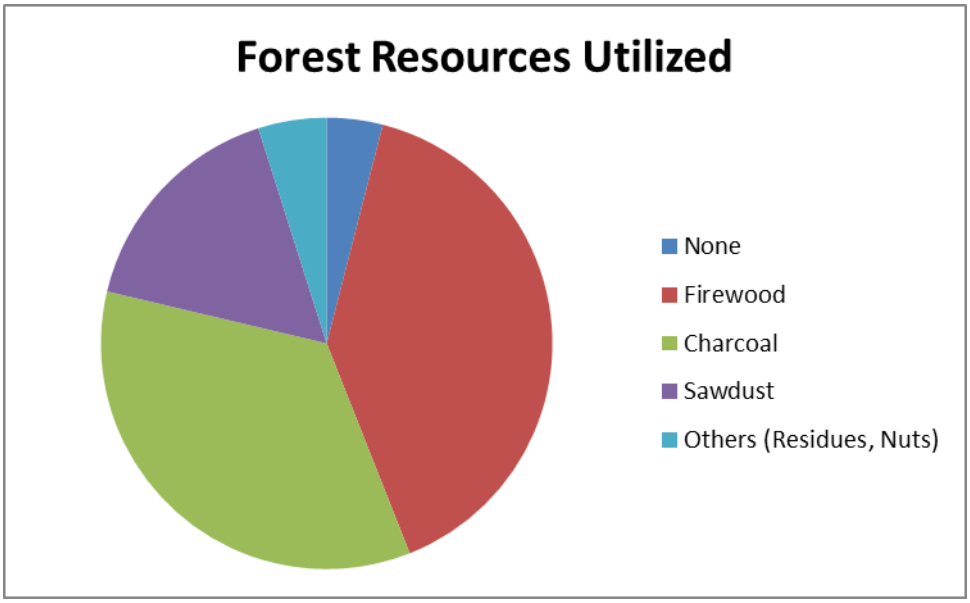

Figure 5: Source of forest energy resources (Field Survey, 2016)

Non-forest Resources Utilized for Domestic Energy Purposes

Figure 6 showed that 77.3 percent of the respondents utilized kerosene as their major source of domestic energy. A very few people (about 4.4 percent) of the total samples utilized gas, 4.9 percent made use of petrol, 3.6 percent relied on electricity, while 1.8 percent uses solar to meet their domestic energy purposes. The implication of the finding is that kerosene is the only non-renewable resources that have the greatest pressure of utilization in rural Nigeria (Fig. 6). Other non-forest resources were not exploited like kerosene.

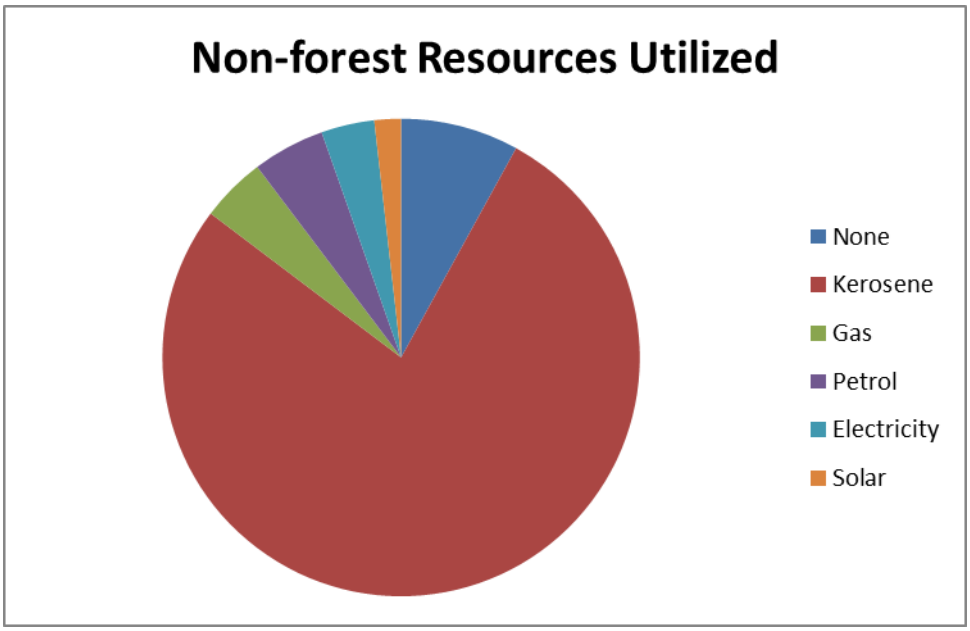

Figure 6: Source of non-forest energy resources (Field Survey, 2016)

Correlation between Average Quantity of Fuel wood Utilized and Amount Spent on Fuelwood by Households

Table 2 shows that household size and monthly income were significant with a p-value of 0.001 and have a positive influence on the instrumental variables (average quantity of fuel wood utilized and amount spent on fuelwood by households). The coefficient of 0.05 recorded for both household size and monthly income implies that for every unit change in household size and income, the quantity of fuelwood utilized and amount spent on fuelwood will increase by 5%.

The distance from home to the source of fuel wood significantly (p-value of 0.05) affects the instrumental variables. The coefficient of the average quantity of fuel wood utilized exhibited a negative value while the other instrumental variable had a positive coefficient. The other exogenous variables (amount spent on substitutes, transportation cost, and the instrumental variables) were not significant. A unit increase in the amount spent on substitutes (kerosene, gas, electricity and solar), the average quantity of fuel wood utilized and amount spent on fuel wood will decrease by 4.7% and 7.7% respectively. The instrumental variable does not collinear as the average quantity of fuel wood has a negative coefficient (-0.0017) and the amount spent on fuel wood has a positive coefficient (0.0021). It implies that the quantity of fuelwood utilized by households doesn't translate to the monetary value incurred on fuel wood.

Table 2: Estimates of the 2SLS Models

Variables	Average Quantity of Fuelwood Utilized by Households (Kg)		Amount Spent on Fuelwood by Households (₦)	
Household Size	.0492***		.0527***	
	(.0175)		(.0224)	
Monthly Income (₦)	-.000264***		-.00116***	
	(8.44e-05)		(.00037)	
Distance from Home to the Source of Fuelwood (Km)		-.00701**	.00410**	
		(.00313)	(.00184)	
Amount Spent on Substitutes (₦)		-.0477	-.0773	
	(.0294)		(.2108)	
Transportation Cost (₦)	-.6826		.0519	
	(1.8479)		(.1414)	
Average Quantity of Fuelwood Utilized by Households (Kg)		1.00		.0021
		(1.00)		(.0025)
Amount Spent on Fuelwood by Households (₦)		-.0017	1.00	
		(.0011)	(1.00)	
Constant	11.2361		-14.2033	
	(4.0214)		(4.1992)	

Field Survey, 2016

*** and ** implies level of significance at 1% and 5% respectively

Figures in parenthesis are standard errors

Sample size = 220

N/B: The independent variables are in logarithms

Environmental Activities Associated with Forest Resource Exploitation

The environment is under threats associated with deforestation, gathering of dead woods (fig. 2 & 3), bush burning and hunting of animals (fig. 7). The implications of these are not far from global warming, nutrient depletion, biodiversity loss, and extinction. Activities like agroforestry, afforestation and bush fallowing that can have a positive impact on the environment are poorly practiced by the rural households (fig. 7).

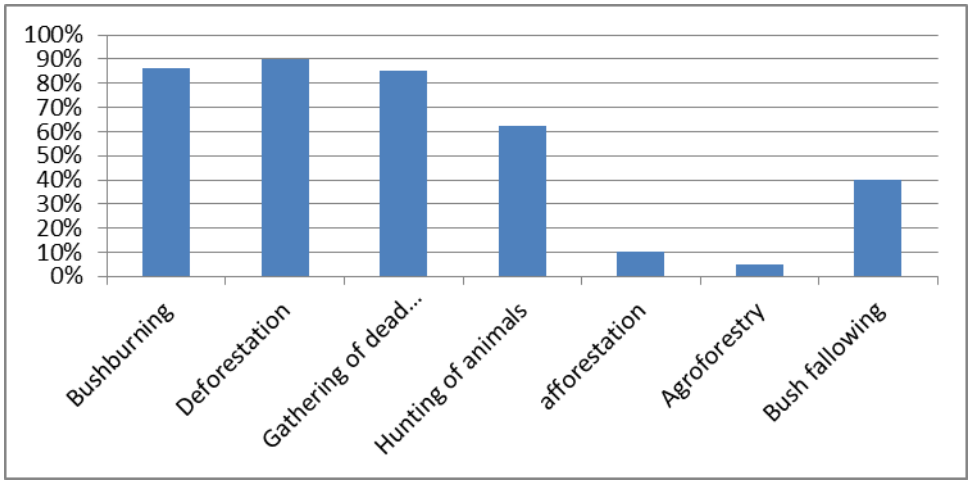

Figure 7: Environmental Activities carried out by Rural Households (Field Survey, 2016)

Conclusion and Recommendations

This study examined whether the quantity of fuelwood utilized equates to its equivalent amount spent on fuelwood by rural households. Descriptive Statistics and 2SLS (a simultaneous equation model) were used to analyze survey data for 225 households. Descriptive statistics results showed that the majority of the respondents (87.1%) which were female and married (70.7%) subsist on biomass and kerosene to meet their domestic energy needs.

The household size and income were the most significant variable ($p < 0.001$) influencing the average quantity of fuelwood utilized vis-à-vis the amount spent on fuelwood consumption. The price of fuelwood being significant does not truly reflect its consumption pattern as the instrumental variables in the 2SLS didn't t collinear. The entire independent variables aside the amount spent on substitutes and transportation costs were significant. Household size had a positive effect on the quantity of fuelwood consumed while amount spent on substitutes was inversely related to the quantity of fuelwood consumed. Eighty-six percent of the respondents engaged in bush burning while 90 percent engaged in deforestation. An average of 324.3kg of fuelwood was exploited freely annually but efforts were not made to replace the lost biomass.

The Government, Non- Governmental Organizations and the private individuals that want to reduce the pressure on forest resources in rural areas must provide abatement technology incentives like energy saving firewood and improved stoves. This can reduce the pressure on fuelwood to a large extent. Politicians canvassing for the votes of the rural populace during power transition can make provision for these incentives to achieve their political will and at the same time ensuring environmental sustainability.

The assertion that the use of energy from fuelwood does not contribute to global warming (UNECE/FAO, 2005) could only be true if the efforts are geared towards the promotion of fast growing agroforestry and hedge/boundaries tree

species so as to match fuelwood consumption. It is evident from the study that there were intense bush burning and deforestation. Also, little of the respondents incorporate tree crops in their cropping system, thus, agroforestry practices would be a formidable tool to combat the negative effects of fuelwood consumption at the expense of renewing these resources. Government should greatly encourage agroforestry practices among rural households and give financial incentives to achieve this purpose.

Since there is no collinearity between the average quantity of fuelwood utilized by households and amount spent on fuelwood consumption, we can say indirectly that rural households spend little or none on fuelwood for domestic purposes. Increase in the cost of accessing or buying fuelwood to reduce the pressure exerted on forest resources may not be an effective economic instrument in Nigeria, rather, subsidizing fossils fuel price. This can lead to an energy switch among rural households.

References

Adepoju A.O., Oyekale A.S. and Aromolaran O. (2012). Factors influencing domestic energy choice of rural households in Ogun state, Nigeria. Journal of Agriculture & Social Sciences ISSN Print: 1813–2235; ISSN Online: 1814–960X 12–029/AWB/ 2012/8–4–129–134.

Alemu Mekonnen (1997). Rural household fuel production and consumption in Ethopia. Department of Economics, Goteberg University, Sweden.

Beyene A.D. (2010). Property rights and choice of fuelwood sources in rural Ethopia. Contributed paper prepared for presentation at the 3rd conference of African Association of Agricultural Economists (AAEE) and the 48th Agricultural Economic Association of South Africa (AEASA), Cape town, September 19-23: 2010.

Fakayode S.B, Animashaun J.O., Babatunde R.O. and Salau R.A. (2013). Determinants of forest resources uses and its implications for environmental sustainability in Nigeria. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

Food and Agricultural Organization (2013). A global assessment of sustainability issues, trends and policies for biofuels and related feedstocks FAO Rome ISBN 978-92-5-107414-5

Gujarati, D.M. (2006). Essentials of econometrics. 3rd Ed. Mc Graw-Hill International: New York.

Ikurekong E.E., Esin J.O. and Mba A.C. (2009). Rural fuelwood exploitation in Mbo Local

Government Area – A Nigerian Coastal Settlement. Ethiopian Journal of Environmental Studies and Management Vol.2 No.3 2009

Julia K.D., Nick H., Kyle M. and Allison R. (2008). The energy crisis of Nigeria: overviews and implications for the future, the university of Chicago: 6-3-2008.

Kammen D.M. (2001). Testimony for the hearing on the role of tax incentives in energy policy for the U.S senate committee on finance, July 11.

Koutsoyiannis A. (2001). Theory of econometrics (2nd Ed.). Palgrave: New York. pp 346-395.

Mashauri A.K. (2011). A review on the renewable energy resources for rural application in Tanzanian. www.intechopen.com. Renewable Energy-Trends and Applications.

Mwangi V.W. (2013). Energy consumption among rural households in Mukaro location of Nyeri county, Kenya. Unpublished M.A thesis in Environmental planning and management, university of Nairobi, Department of Geography and Environmental studies.

Nabinta R.T., Yahya M.K. and Olajide B.R. (2007). Socio-economic implications of rural energy exploitation and utilization on sustainable development in Gombe State, Nigeria. J.Soc.Sci.,15(3); 205-211.

Ojo C.O. and Chuffer L. (2013). Accessibility to domestic energy among rural households; case study of Damboa Local Government Area of Borno State, Nigeria. Greener journal of social sciences vol. 3(3),pp. 166-170, March 2013.

Okoye J.K. (2007). Background study on water and energy issues in Nigeria to inform the national consultative conference on dams and development."

Onyeneke R.U., Nwajiuba C.U., Nwosu C.S. (2015). Determinants of fuelwood consumption among farming households in Imo state, Nigeria. Journal of Environment Protection and Sustainable Development Vol. 1, No. 2, 2015, pp. 54-58

Preston K.M. (2012). Fuelwood collection and consumption: a case study in Lupeta, Tanzama. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Forestry, Michigan Technological University.

Stephane C., Serge G. and Arnand R. (2006). Household energy choices and fuel wood consumption: An econometric approach to the French Data. INRA, UMR 365 Ecocnomic Forestiere, F-5400 Nancy, France.

Wikipedia (2013). Renewable energy resources, www.wikipedia/renewable energy.

Wikipedia (2014). South-western geographical zone of Nigeria.