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Factors Influencing Domestic Energy Choice of Rural Households in Ogun State, Nigeria

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ABSTRACT

Choices of domestic energy that are made by rural households are able to influence environmental conservation and sustainable development. This study determined the factors influencing choice of energy by rural households. Data were collected from randomly sampled households. Analysis was done with descriptive statistics and Logit regression. Result showed that the largest proportion of the respondents used kerosene oil for cooking and lighting. Logit regression results showed that there was gender influence in fuel wood choice. Also, illiterate household heads had higher likelihood of choosing charcoal. Choices of kerosene oil and electricity were influenced by proximity. It was recommended that efforts to address energy problem in rural areas should take cognizance of ensuring availability and affordability of cleaner energy sources, among others. © 2012 Friends Science Publishers

Key Word: Energy; Rural households; Conservation; Logit regression

INTRODUCTION

Petroleum products and electricity constitute the most widely used domestic energy sources in Nigeria. Because of inefficiency of the centralized energy industry, prices of these products have been unstable, while supply is grossly inadequate for the rapidly growing population. Therefore, the economy had suffered perennial energy crises with some huge economic losses and social consequences (Shittu *et al.*, 2004). The political dimension of the crises can be vividly portrayed from the fact that while federal government often makes promises of energy sector reforms as ambitious legislative work, corruption in the public sector stands as impediment in the implementation processes.

World Bank (1993) linked Nigeria's energy crises to some inadequacies in supply and distribution, pricing, planning and manpower. Unmet households' energy demands have some adverse effects on the living standards of the population, with grossly degenerated income and energy poverty. The situation is more pathetic when one realizes the magnitude of non-renewable resources that the nation is naturally endowed with (Iwayemi, 2008). It should also be noted that the mechanism for commodity price transmission is very strong when energy products are affected. This is because of weaknesses and inefficiency of existing transportation systems. Therefore, energy price increases or its acute shortages portend serious welfare losses to households because of reduction in their income purchasing power.

Although Nigerian rural households rely more on biomass fuels than their urban counterparts, they are not completely shielded from adverse economic impacts of energy pricing policies. A number of studies have illustrated increasing reliance of the poor on diverse forms of coping and survival strategies resulting from domestic energy price hikes. Cecelski (1985) found that when there was scarcity of fuel wood, rural people shifted to alternative fuels such as cattle dung, crop residues, coconut husks, rice-hulls, millet stalks, dried herbs etc.

Agarwal *et al.* (1986) reported that in the event of fuel scarcity in some third world countries, rural landlords can gather firewood and crop residues from their own property, while the landless must depend on wood from common lands or may be allowed to gather from other people's land in exchange for their labor. Smil (1990) found that hike in fuel prices compels shift from modern energy sources to traditional sources (fuel wood). It was noted that each family had to devote more of its time, labor and household income to searching for and buying fuel wood.

International Energy Agency (IEA, 2006) noted that in order to meet the households' energy needs, about 70% of rural households in sub-Saharan Africa rely on fuel wood, charcoal, kerosene oil or wood

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wastes. However, dependence on biomass energy sources are laden with several environmental challenges that are associated with deforestation and land degradation (World Energy Council, 1999; Faye, 2002). This raises the concern of sustainability. Adverse health implications of biomass fuel usage have also constituted some concerns to policy makers. Specifically, indoor air pollution that results from burning of biomass is responsible for some worrisome health hazards (Muchiri & Gitonga, 2000). The World Health Organization (WHO) estimated that about 1.5 million annual premature deaths can be linked to indoor air pollution from the use of solid fuels (IEA, 2006). Incidences of respiratory infections and cataracts in some rural areas have been linked to emitted smokes from biomass fuels (UNDP/ESMAP, 2003).

Inducement of energy switch from biomass to cleaner energy through workable energy policies is expected to offer safety to rural people. This is based on the energy ladder model of household fuel utilization. Leach (2000) simplified the model by proposing that income is a major driver of household fuel usage. Switching from dirty energy sources to cleaner ones is a linear function of income. However, income and substitution effects are important issues for explaining consumer's behavior (Bardhan *et al.*, 2001). Then it can be hypothesized that as income increases, demand for fuel wood decreases because of its inferiority among the commodity bundles. This study therefore seeks to fulfill the objective of examining the determinants of energy choice among rural households in Ogun state, Nigeria. No doubt, increasing population pressure and persistent pressure on the vegetation justify the study. The remaining parts of the paper contain materials and methods, results and discussion and recommendations.

MATERIALS AND METHODS

Study area: The study was carried out in Odeda Local Government Area (LGA), which is one of the twenty LGAs in Ogun State, Nigeria. The headquarters is at Odeda which is located some 20 km from Abeokuta. The council area has an extensive landmass mostly grassland with an area of 1263.45 km^2 and a population of 109,449 according to the 2006 population census figures. The people are predominantly small scale farmers growing food crops like cassava, yam, cocoyam, plantain, maize with cocoa as cash crop.

Source of data and sampling procedures: Primary data were used for the study. They were collected from cross-sectional survey of 130 households using structured questionnaire. A multistage sampling procedure was employed in selecting the representative households. The first stage involved division of the local government area into the 10 existing wards. At the second stage, 13 households were randomly selected from these wards, making a total of 130 respondents.

Logit regression model: Logit regression method was used to examine the factors that influence choice of energy type used by rural households. Analyses were run separately for each of sources comprising fuel wood, charcoal, kerosene oil and electricity. The estimated model can be generally stated as:

$$E_{ji} = b_j + b_{j1} X_1 + b_{j2} X_2 + b_{j3} X_3 + b_{j4} X_4 + \text{-------} + b_{jn}X_n + e_j \qquad 1.$$

Where j represents the categories of energy sources and E_{ji} represents the binary energy choice variable (jth) by ith household. In this instance, fuel wood model has yes = 1, 0 otherwise, charcoal model having yes =1, 0 otherwise, kerosene oil model having yes = 1, 0 otherwise and electricity model having yes =1, 0 otherwise. b_j represents the constant term and b_{jn} are the estimated parameters for each of the models. X_n are the explanatory variables and the included ones are sex of household head (male=1, 0= otherwise), age of the household head (in years), household size, no formal education (yes=1, 0 otherwise), primary education (yes =1, 0 , otherwise), secondary education (yes =1, 0 otherwise), marital Status (married =1, 0 otherwise), farm ownership (yes = 1, 0 otherwise), farm size (in acres), mode of transportation to energy source (walking=1, 0 otherwise), occupation of household head (farming =1, 0 otherwise) monthly expenditure on energy category (₦). e_j is the error term.

RESULTS

Socio-economic characteristics of the respondents: Table I shows the distribution of the respondents' socio-economic characteristics. It revealed that 60.8% of the household heads were males. It also shows that majority of the respondents (64.5%) were aged above 45 years, while only about 5.5% were below 35 years of age. The average age of all the respondents is 45 years. With respect to marital status of the respondents, 24.5% of the households had between 1-5 members, 67.7% of the household had between 6-10 members, while 7.7% of the households had more than 10 members. Most of the respondents (63%) had no formal education, 27.7% had primary education, 18.5% had secondary education, while only 6.9% had tertiary education.

Also, 72.3% of the household heads were married, 13.0% were divorced, 7.7% were widowed, while 7.0% were separated. This is an indication that most of the household heads were married. Majority (46.1%) of the house heads were into farming as primary occupation, 19.2% were artisan, 23.1% engaged in trading, while 11.6% were salary earners. The high percentage of households that were engaged in farming was expected because the study was carried out in a rural area. The table also revealed that 44.6% of the households earned

Table I: Distribution of respondents' socio-economic characteristics

Socio-economic characteristics	Frequency	Percentage
Sex		
Male	79	60.8
Female	51	39.2
Age		
Below 35	5	5.5
35 -45	39	30
Above 45	86	64.5
Household size		
1 – 5	32	24.5
6 – 10	88	67.7
Above 10	10	7.7
Education		
No formal education	63	48.5
Primary education	36	27.7
Secondary education	24	18.5
Tertiary education	9	6.9
Marital status		
Married	94	72.3
Divorced	17	13.0
Widowed	10	7.7
Separated	9	7.0
Occupation		
Farming	60	46.1
Artisan	25	19.2
Trading	30	23.1
Salary earners	15	11.6
Monthly income (₦)		
Below 10,100	8	6.1
10,100 <20,100	18	13.8
20,100 <30,100	17	13.1
30,100 –<40,100	58	44.6
Above 40,100	29	22.4

Table II: Distribution of respondents by farm ownership

Description	Frequency	Percentage
Own land		
Yes	95	73.1
No	35	26.9
Farm size		
None	35	26.9
< 1	25	19.2
1-2	54	41.5
>2	16	12.4

Tables III: Fuel types and mode of usage

Fuel Types	Cooking		Heating		Lighting	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Fuel wood	69	53.1	20	15.4	4	3.1
Charcoal	71	54.6	23	17.7	5	3.8
Kerosene oil	103	79.2	70	53.9	97	74.6
Electricity	10	7.7	8	6.2	95	73.1

between ₦30,100 and ₦40,100, while only about 6% earned below ₦10,100 every month. The average household income in the study area was about ₦30,000.

Farm ownership and size: Table II shows the distribution of the respondents by farm ownership. About 73.1% of the household heads owned a farm, while 26.9% of the house heads did not own a farm. This is an indication that most of the household heads were engaged in farming activities as either primary or secondary occupation. The table also shows the distribution of household heads by farm sizes. It reveals that 26.9% of household heads had no farm, 19.2% owned less than 1 acre; 41.5% had between 1–2 acres while only 12.4% of the household heads had greater than 2 acres. This showed that those that cultivate between 1–2 acres are the majority in the study area. The average farm size stood at 1.3 acres.

Domestic energy types and usage patterns: Households' choices of energy types and their usage patterns are presented in Table III. Majority of the respondents (53.1%) used fuel wood for cooking, 15.4% used it for heating while only 3.1% used it for lighting especially during festive periods. Charcoal was used by 54.6% of the households for cooking, 17.7% for heating and 3.8% for lighting. kerosene oil was the most widely used source of fuel in the area as about 79.2% of the households made use of it for cooking, 74.6% for lighting and about 6% for heating. Electricity was the least used of the energy sources in the study area. This could be attributed to the fact that respondents could not afford the high cost of electricity and also because of its erratic supply.

Table IV presents the fuel users categories with the number of the households that fall into each of the categories. Majority of the rural households (63.8%) made use of only one type of fuel for cooking, out of which kerosene oil was the most predominant fuel used. Next to this is fuel wood. Electricity, however, was used by single fuel users for cooking; which could be attributed to the fact that most of them could not afford the use of electricity because of their low income and also its erratic supply. Among the multiple fuel users, two fuel users were the most common and the combination mostly used is fuel wood and charcoal. Next to this is fuel wood and kerosene oil. Also, among the three fuel users, the combination frequently used by the respondents is fuel wood, charcoal and kerosene oil. The least is charcoal, kerosene oil, and electricity. However, only 0.8% of the respondents used all four fuel types.

Determinants of household energy use choice: The regression analysis was carried out to identify the variables that significantly affected energy use of household. This was done using four separate regression models for each of the energy types.

Choice of fuel wood: In the analysis for fuel wood, the model produced a good fit because the Chi square is significant ($p<0.01$). Table V shows the factors influencing the use of fuel wood as energy source in the study area. The parameter of sex had a negative sign but was significant ($p<0.10$). This implies that male headed households had lower probability of using fuel wood as energy source. This is expected because females are traditionally responsible for fetching fuel wood in many Nigerian rural areas. Occupation of the household head

is also negatively significant ($p<0.05$). This reveals that households engaged in farming had lower likelihood of using fuel wood. This was contrary to expectation because farmers are expected to have access to fuel wood from their farms. Similarly, it may also indicate scarcity of fuel wood or higher tendency of farmers switching to safer energy sources.

Choice of charcoal: Estimated model for charcoal produced a good fit for the data because the Chi square was significant ($p<0.01$). Table VI shows that the coefficient of no formal education was significant ($p<0.10$) and positive showing that household heads with no formal education are more likely to use charcoal as energy source because of its lower price as compared to other energy sources such as kerosene oil. Increase in monthly expenditure on charcoal will decrease the likelihood of using it as energy source because high price will make households to switch to other energy sources.

Choice of kerosene oil: Estimated model for kerosene oil produced a good fit for the data because the Chi square was significant ($p<0.01$). Marital status was positively significant ($p<0.05$), which implies that the married people were more likely to increase their usage of kerosene oil (Table VII). The mode of transportation parameter is significant ($p<0.10$) and with positive sign which showed that if the kerosene oil source is trekable, the likelihood of families to use it increases. Parameter of occupation of the household heads was negative ($p<0.05$) implying that households headed by farmers had lower likelihood of using kerosene oil.

Choice of electricity: Estimated model for electricity as energy source produced a good fit for the data because the Chi square was statistically significant ($p<0.01$). Table VIII shows that the coefficient of mode of transportation was positive and significant ($p<0.10$), implying that if the distance to electricity bill paying point or buying units could be trekked, the likelihood of using electricity increases. Monthly expenditure on electricity is significant ($p<0.01$) with positive coefficient. This indicates that the likelihood of using electricity increases despite high monthly expenditure on it because electricity usage is seen as a necessity for the households.

DISCUSSION

The results indicated that the use of electricity was very low in the study area due to its irregular supply. Electricity can be enjoyed regularly at personal cost by the rich via usage of generators with its associate pollution. The situation in rural areas is worse, where there are countless uncompleted rural electrification projects. Togola (2005) reported that about 73% Nigerians lack access to electricity, thereby making economic development very difficult. Igbinovia and Orukpe (2007) also noted that utilization of adequate form of energy is a propellant for job creation and socioeconomic development. Inadequate access to electricity is a major limitation to development of rural cottage industries.

The results showed that kerosene oil is the energy

Table IV: Usage pattern of fuel for cooking purpose among households

User categories	Frequency	Percentage
Single fuel users	83	63.8
Fuel wood	33	25.4
Charcoal	14	10.8
Kerosene oil	35	26.9
Electricity	1	0.7
Multiple fuel users. *(two fuels)*	30	23.1
Fuel wood &charcoal	8	6.2
Fuel wood & kerosene oil	6	4.6
Fuel wood & electricity	0	0
Charcoal & kerosene oil	12	9.2
Charcoal & electricity	1	0.7
Kerosene oil & electricity	3	2.4
Multiple fuel users. *(three fuels)*	16	12.3
Fuel wood, charcoal & kerosene oil	12	9.2
Fuel wood, charcoal& electricity	1	0.7
Charcoal, kerosene oil, electricity	2	1.5
Kerosene oil, electricity & fuel wood	0	0
Multiple users. *(four fuels)*	1	0.8
Fuel wood, ,charcoal, kerosene oil & electricity	1	0.8
All users	130	100

Table V: Logit regression results of factors affecting choice of fuel wood as energy source

Variables	Coefficient	Standard Error	Z
Sex	-1.7462*	1.0477	-1.66
Age	0.1468*	0.0808	1.82
Household Size	-0.3524	0.2466	-1.43
No formal Education	-0.5315	1.1488	-0.46
Primary Education	-0.9063	1.3036	-0.70
Secondary Education	-1.1734	1.6929	-0.69
Marital Status	-0.5657	1.2237	-0.47
Farm Ownership	-2.4430	1.8238	-1.34
Farm Size	-0.0988	0.6831	-0.14
Mode of transport	-1.4849	0.9373	-1.58
Occupation	-2.9135**	1.3266	-2.20
Monthly Expenditure on Fuel wood	-0.0045	0.0056	-0.87
Constant term	257.7052	100.6661	2.56
Pseudo R^2	0.7239		

*Significant at 10%, **Significant at 5% ***Significant at 1%

Table VI: Logit regression results of factors affecting choice of charcoal as energy source

Variables	Coefficient	Standard Error	Z
Sex	-0.0446	0.7314	-0.06
`Age	0.0188	0.0420	0.45
Household size	0.1142	0.1539	0.74
No formal education	1.7851*	1.0107	1.77
Primary education	0.9062	1,1685	0.78
`Marital status	-0.2486	0.8073	-0.31
Farm ownership	-0.1679	1.3151	-0.13
Farm size	-0.2855	0.5425	-0.53
Occupation	-0.0617	0.8159	-0.04
Expenditure on charcoal	-0.0037**	0.0016	-2.34
Constant	35.2632		
R^2	0.5812		

*Significant at 10%, **Significant at 5% ***Significant at 1%

source with highest usage. However, in our results, kerosene oil recorded the highest usage and similar findings had been reported by Aina (2001). The Nigerian government sometimes put in place distribution mechanisms that ensured availability of kerosene oil. However, there had been some perennial scarcity and product adulterations. Many accidents that resulted from such adulterated kerosene oil that were mixed with petrol had claimed several lives and rendered many with some form of disabilities. Charcoals and fuel wood also recorded high usage. Similar result had been found by Fawehinmi and Oyerinde (2002). Courier (1986) indicated that fuel wood constitutes about 80% of energy usage in the Third World. This has some serious environmental implications because households often engage in indiscriminate cutting of trees (Oppong, 1992; Aina, 2001).

The logistic regression results were presented in Tables V-VIII. In Tables V and VI, household heads that were not formally educated reported higher likelihoods of using charcoal and fuel wood. Aina (2001) found that irrespective of the educational status of the household heads, economic status was important in determining the choice of energy made by households. Conventionally, illiterate household heads are expected to have limited understanding of some environmental and health hazards that are associated with charcoals and fuel wood usage. They are also likely to have lower income.

In Table V, households that were headed by males had lower likelihood of using fuel wood. Female headed households may be poorer than their male-headed counterparts due to low access to production resources as a result of traditional gender issues in resource allocation. This can also be linked to the fact that female members of households are some time ago directly responsible for fuel wood gathering. Adedayo *et al.* (2010) found that fuel wood gathering among rural women can be linked to their quest for more income. This implies that it could be a form of livelihood for rural women.

Mode of transportation was significant and positive in Tables VII and VIII. This shows that availability of kerosene oil and electricity paying point in distances that can be trekked resulted in higher likelihood of usage. Aina (2001) noted that availability is an important issue for households' energy demand in Nigeria. Also, higher prices would increase usage of electricity. Fawehinmi and Oyerinde (2002) emphasized the relevance of price for the choice households make on the type of energy in Nigeria.

In conclusion, a lot has to be done to ensure provision of safer and cleaner sources of energy to rural households. Availability, affordability and convenience of usage are critical issues to be taken into consideration when making choices among available energy sources. There is the need for government's intervention for making kerosene oil, which is mostly used in rural areas, is available to rural poor. This will reduce pressure on the forest and also reduce time for fetching fuel woods. Such effort will tremendously benefit female headed households, who utilized more fuel wood. Also, provision of adequate incentive for educating the people will give them opportunities of getting better jobs and thereby depend less on dirty sources of energy. Our findings showed that respondents without formal education had higher likelihood of using fuel wood and charcoal as major sources of energy. However, if prices of fuel wood and charcoal increase due to scarcity less of them would be bought. This further underscores the necessity of ensuring provision of electricity to rural households at affordable prices. There is also a need to ensure that the supply is regular. If this is not done, scarcity of fuel wood and charcoal could lead to more environmental pollution because households will be compelled to switch to plastics and other combustible materials that can increase chances of exposure to health hazards.

Table VII: Logit regression results of factors affecting choice of kerosene oil as energy source

Variable	Coefficient	Standard Error	Z
`Sex	1.1667	0.7689	1.52
Age	0.0578	0.0383	1.51
Household size	-0.260	0.1849	-1.41
Primary Education	1.5493	1.2682	1.22
Secondary Education	0.1283	1.2538	0.10
Marital Status	1.7536**	0.8439	2.08
Farm Ownership	1.9013	1.3783	1.38
Farm size	0.1092	0.6434	0.17
Mode of Transportation	1.2816*	0.7559	1.70
Occupation	-2.5628**	1.01821	-2.52
Constant	-2.5628		
Pseudo R^2	0.6809		

*Significant at 10%, **Significant at 5%

Table VIII: Logit regression results of factors affecting choice of electricity as energy source

Variable	Coefficient	Standard Error	Z
Sex	1.0481	0.9859	1.06
Age	0.0191	0.0427	0.45
Household size	-0.1089	0.19052	-0.57
Primary Education	0.9742	2.6567	0.45
Secondary Education	0.5706	2.2006	0.69
Marital Status	1.3428	1.1190	1.20
Mode of Transport	1.7200*	0.9008	1.91
Occupation	-1.1401	1.0903	-1.05
Expenditure on Electricity	0.0015***	0.0003	4.92
Constant term	-4.0071		
Pseudo R^2	0.6405		

*Significant at 10%, **Significant at 5%, ***Significant at 1%

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