

Energy Utilization Pattern and Socio-Economic Evaluation of Household Fuel Wood Consumption: A Case Study of Kano Metropolis, Kano State, Nigeria

¹U. M. Abdulhamid, ²Z. Y. Abdullahi, ³S. A. Safiyanu, ⁴I. Suleiman,
⁵A. U. Shu'aib, ⁶M. A. Dambatta

¹Department of Management Science, Kano State College of Arts and Science (CAS, Kano)

^{2,3,4,5}Department of Agricultural Economics and Extension,

⁶Department of Forestry, Fisheries and Wildlife,

Kano University of Science and Technology, Wudil, Nigeria

Abstract

This study analyzed energy utilization pattern and evaluate fuel wood consumption in Kano metropolis. Multi-stage sampling was used in data collection using both purposive and random samplings in selecting the respondents. Primary data were collected using structured questionnaire. A total of 200 domestic consumers were considered for the study. The analytical tools employed include, descriptive statistics and multiple regression analysis. The pattern of energy consumption revealed that majority (64.5%) consumers relied solely on fuel wood as their main source of energy. The result further revealed that availability/accessibility, affordability and low level of consumer's income as the main reason for adopting fuel wood as their major energy source. Result of regression for the determinant of quantity of fuel wood consumed among consumers revealed that, age, household size and price of alternative energy sources had positive coefficient and were statistically significant while monthly income, education and price of fuel wood had a negative sign and were also statistically significant. The major constraints militating against the reduction of fuel wood consumption include low level of income, high price of fuel wood and non-availability of other energy sources. It is therefore recommended that Government should intervene and urgently reduce the price of alternative energy sources to fuel wood such as kerosene, liquid petroleum gas(LPG) and electricity. There is also need for a strong policy that will ensure availability, accessibility, affordability and timely delivery of other energy sources to reduce the fuel wood consumption in the study area.

Keywords: Energy Utilization, Socio-Economic Evaluation, Fuel Wood

Corresponding Author:

U. M. Abdulhamid

Background to the Study

Fuelwood energy has been used for thousands of year for cooking and heating and it remains the primary source of energy throughout much of the world (FAO, 2008; Gregory *et al.*, 1999). Biomass energy is the largest source of renewable energy and accounts for 10.4% of total global energy supply and 77.4% of global renewable energy supply (Carlos and Khang, 2008). Fuelwood is by far the most important source of biomass energy as it is the primary energy source for more than 2 billion, primarily poor, people (Pattanayak *et al.*, 2004; Troncoso *et al.*, 2007) and because its harvesting contributes to forest degradation in many regions (Pattanayak *et al.*, 2004). Fuel wood extraction does not necessarily lead to forest degradation (FAO, 1997; Palmer and Macgregor, 2009). However, it often leads to forest degradation where demands for fuelwood are high, where forest resources are limited (particularly high elevation and arid environments where plant growth is constrained by climate), and where alternative energy resources such as kerosene or Liquid Petroleum Gas (LPG), are unavailable, (Gregory *et al.*, 1999).

In developing countries, most of the rural as well as urban communities have less access to modern and clean energy sources and mostly depend on traditional fuel /biomass (woods, twigs, leaves, charcoal, animal dung and crop residue) for virtually all their energy requirements. It is estimated that approximately 2.5 billion people in developing countries rely on biomass fuels to meet their cooking needs (IEA 2006).

In Nigeria, the vast majority of the populace depends on forest resources in meeting their various energy uses. According to FAO (2005) Nigeria lost 81% of its old growth forest in just 15 years (1990-2005) as a result of uncontrolled subsistence agriculture and the collection of fuel wood which have destroyed the countries forest. Eleven Northern states have been swallowed up by advancing Sahara desert. The nexus between poverty and energy can be described in terms of quality and quantity of energy used. Generally, most poor households use biomass fuels because of affordability and they do not have sophisticated energy equipment (such as gas cookers, electric cookers). It has been estimated that about 86% of rural and urban households in Nigeria depend on fuel wood as their source of energy (Williams, 1998). Nigeria consumes over 50 million metric tonnes of fuel wood annually, a rate, which exceeds the replenishment rate through various afforestation programme (ICCDD, 2000).

Findings from the study can help government and NGOs to refine their strategies regarding energy consumption in Kano metropolis. Particularly, the study will highlight factors that can be controlled by mean of policies and factors that need incentives, the work will also be an important contribution to environmental protection. Finally, the study will help individuals and researchers wishing to carry out related study in the future.

Objectives of the Study

this research therefore tends to answer the following objectives:

- i. Describe the sources of fuel wood and energy consumption pattern of household in the study area.

- ii. Determine the socio-economic characteristics that influence fuel wood consumption.
- iii. Identify and describe the constraints militating against the reduction of fuel wood consumption in Kano Metropolis.

Methodology

The Study Area

Kano state lies between latitude $10^{\circ} 33'$ and $12^{\circ} 37'$ North of equator and longitude $7^{\circ} 43'$ and $9^{\circ} 35'$ East of Greenwich (KNSG, 2002). Kano metropolis has temperatures normally ranging from 36°C to 16°C . It is located within the Sahel Savannah which is semi-arid. The city is predominantly peopled by Hausa and Fulani ethnic groups who are mostly Muslims. Other tribes like Yoruba and Ibos have also settled in the metropolis. This provides the inherent qualities that describe the climate and vegetation (Sudan Savanna) with abundant energy sources which include electricity, LPG, kerosene, charcoal and fuelwood. Kano metropolis consists of eight local government Areas (LGAs) The LGAs are Dala, Fagge, Gwale, Kano Municipal, Kumbotso, Nassarawa, Tarauni and Ungogo and has a total land area of 499 kilometers square. Kano metropolis has a population of 2,882,857 which consist of about 31% of the population of the state based on the 2006 census (NPC, 2006). Using the annual growth rate of 3.3 % the projected population of Kano metropolis by the year 2013 could be 3,580,906.

Kano is the commercial centre of Nigeria and therefore has various fuelwood markets which are patronized by people living within and outside the state and even outside Nigeria. "Mariri fuelwood Market is one of the largest markets for fuelwood in Nigeria". However there are many fuelwood markets that are located within the metropolitan area. The diversity of the population in the metropolitan area could therefore lead to differences in consumer energy choices and consumption pattern of fuelwood in the study area.

Sampling Technique

Multi-staged sampling technique was used for the study. The first stage involved purposive selection of four local governments out of the eight Local Governments (LGs) that made up of Kano metropolis. The four local Governments (LGs) selected include Fagge, Kano municipal, Kumbotso and Nassarawa. The second stage was the purposive selection of four fuel wood markets from the selected local governments, one from each local government selected. The four markets selected for the study include; Kofar Wambai fuel wood market from Kano municipal, Kara from Faggelocal government area, Gama fuel wood market from Nasarawa and Mariri fuel wood market from Kumbotso local government area.

The last stage was the systematic selection of 200 domestic consumers, out of which 50 were identified and selected at the point of purchase of fuelwood from each market. The respondents were randomly selected by truncation in such a way that first male or female buyer was selected while the second, third, fourth and fifth were ignored then the sixth buyer was considered, this process continued until the sample size allocated was covered.

Data Collection Method

Primary data used for the study was obtained through the use of structured questionnaires and interviews with consumers in the study area. The data were collected from the two hundred household(200). The collection of data was through fuel wood markets surveys by administering questionnaire to consumers at point of purchase. The questionnaire contained both open-ended and close-ended questions. Data collected include socio economic characteristics, pattern of energy consumption, sources of fuel wood, use of alternative energy sources and constraint against the reduction of fuel wood consumption in the study area, etc.

Analytical Techniques

The collected data were processed and analyzed using the Statistical Package for Social Scientists (SPSS). Analytical tools used include descriptive statistics such as frequency, percentage, mean, standard deviation, charts to achieve objective ii, objective iii, and iv while multiple regression models was used to achieve objective i.

Descriptive Statistics

Descriptive Statistic tools such as frequency, percentages, mean, charts, standard error and standard deviation were used to describe the sources of fuel wood and energy consumption pattern as well as the constraints militating against the reduction of fuel wood consumption while multiple regression model were used to determine the relationship between socio-economic characteristics and fuel wood consumption in Kano Metropolis.

Regression Analysis

Multiple regression models are specified as follows:

The Model specification for socio-economic characteristics of domestic consumers can be mathematically expressed as:

$$Y = f(X) \text{ ----- (1)}$$

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \text{-----} + \beta_7 X_7 + U \text{----- (2)}$$

Where;

Y = Quantity of fuelwood Consumed (Kg)

$\beta_0 - \beta_7$ = coefficient of the regressor

U = error term

X_1 = Age (years)

X_2 = Household size (number person)

X_3 = Average monthly income (₦)

X_4 = Level of Education (years of formal education)

X_5 = Main occupation (multiple) 1 for trading, 2 civil servants, 3 agricultures, 4 others.

X_7 = price of fuelwood substitute (kerosene) (₦)

X_8 = Price of fuelwood (₦)

Result and Discussions

Sources of Fuelwood and common tree Species used for Fuelwood

Table 6 shows the sources of fuelwood supply to the Kano metropolis. It shows that forest is the source of greater proportion (70%) of the fuelwood in the study area. Forests from different neighboring state such as Northwest through Katsina road, South/North central through Zaria road, North east through Maiduguri road, North East through Hadeja road even though Katsina-Sokoto border and those from Southern part of the country provide the study area with large quantity of fuelwood of high quality from heat value and economic standpoint.

Tree plantations are second major sources of fuelwood with 22% and farm land provides the study area with only 8%. The implication of this is that if the trend continue the forest game reserves would continue be intensively and extensively exploited thereby regenerating the problem of deforestation in many parts of Nigeria. The most common tree species used for fuelwood are shown in Table 6 also the result revealed that, although there are many different species used for fuelwood. The most common ones utilized in the study area are *Prosopisafricana*, *Terminal glaucescens*, *Azadirachta indica*, *Tormarindus indica*, *Anogeissus leiocarpus* and *Parkia biglobosa* with *Anogeissus leiocarpus* being the most preferred specie. This result is in line with the findings of Ibrahim, *et al.*, (2013) they reported that, forest is the greater sources of fuelwood supply to Dala local Government area of Kano state.

Pattern of energy consumption in the study area

Figure 1 present energy consumption patterns among domestic consumers, that is fuelwood and other energy types that are combined with fuelwood. The result shows that, majority of domestic consumers (64.5%) relied on fuelwood only as the only source of energy for their domestic household activities while 24.5% combined fuelwood with kerosene, 7% combined fuelwood with charcoal and only 4% of the respondent combined fuelwood with LPG. It can be noted that consumers also use kerosene as a source of energy, which implies that an increase in the price of kerosene may likely to have a marked effect on fuelwood consumption.

The results further revealed that all consumers may either using fuelwood only as main source of energy or combined fuelwood with other energy sources for both domestic and non domestic activities regardless of their income level. This pattern of energy consumption is not consistent with energy ladder hypothesis which affirm that, low income consumers use biomass resources, middle income use transition fuels and high income consumers use modern fuels. However, the energy use pattern confirms energy stacking hypothesis. That is instead of abandoning lower energy types as income increases, consumers tend to stack different forms of energy.

Socio Economic Characteristics of Fuel Wood Consumers

Socio economic characteristics is an economics and sociological combined total measures of person's work experience and of an individual's or family economic and social position in

relation to others, based on income, education and occupation. This component presents socio-economic characteristics of fuelwood consumers. The variables are based on the qualitative and quantitative socio economic variable. The socio economic variables identified for this research include gender, marital status, level of education, major occupation, age, household size and income level of fuelwood consumers.

The dependent variable was quantity of fuelwood consumed in kilogram while independent variables in the analysis were age (years), household size (number), monthly income (₦), educational status (years), occupation (multiple), price of fuelwood (₦), price of Kerosene(₦). The multiple regression result showing the relationship between socio economic characteristic and fuelwood consumption.

Age of the respondents

The coefficient of age was positive and significant at 1% level of probability, implying that as age increases fuelwood consumption increases. This might likely be possible because aged consumers have more responsibility in their households that could require the use of fuelwood more than the younger consumers. This is in line with the findings of (Onyenekeet *al.*, 2015) who reported that Age is positively and significantly related to fuelwood consumption. The size of household was also statistically significant at 5% probability level. This implies that as the number of dependents increases in the household, the consumption also increases thereby leading to utilization of more fuelwood. The coefficient of household size was 0.186, implying that for every unit change (increase) in household size in the study area fuelwood consumption might likely increase by 18.6 percent. This finding is in conformity with findings of Anthony (2012) who stated increase in household size lead to an increase in quantity of fuelwood consumption in Kogi state, Nigeria.

Monthly Income of the respondents

Monthly income had a negative statistical significant coefficient. This shows that income elasticity was negative, indicating that fuelwood is not a luxury item but inferior good to the consumers. With coefficient of -0.151 (15%), one can assert that for every 1 unit increase in monthly income among fuelwood consumers in the study area, the consumers may likely reduce consumption of fuelwood by 15.1%. The implication of this is that as the income of household increases, there is the tendency that one would go for alternative energy sources such as kerosene, cooking gas, or electricity. This also coincide with what was reported by (Anthony 2012) who reported that monthly income of the consumers is negative and has a significant effect on quantity of fuelwood consumed or demanded.

Price of Kerosene

The price of fuelwood substitutes (kerosene) was significant with positive coefficient. This implies that an increase in the price of alternative energy sources (kerosene) may result to more consumption of fuelwood. The fairly positive increase in elasticity of kerosene price (0.322 or 32.2%) is in line with theoretical concept, that the higher the price of the substitute product (kerosene in this case), the higher the consumption of the product (fuelwood). So for every unit increase in kerosene price, there may be 32.2% increase in the quantity of fuelwood

consumed by the fuelwood consumers. This finding also agrees with the finding of Ebe (2014) who reported that, price of fuelwood substitutes was significant with positive relationship in urban area of Enugu state.

The price of Fuelwood

The price of fuelwood showed negative relationship ($-0.29.8$ or 29.8%) implying that the demand function satisfied a prior expectation. The coefficient of -0.298 or 29.8% recorded for price of fuelwood implies that for every unit change in price of fuelwood consumed in the area the quantity of fuelwood may falls by 29.8% . This is in line with the theory of demand which states that “the lower the price of the commodity, *ceteris paribus*, and the higher quantity be demanded”. This situation could be explained by the fact that, there are other alternative sources of energy in the study area that consumers may fall back on when prices of fuelwood increases. This finding is in conformity of (Ebe2014) who stated that, the price of fuelwood was negative and significantly related to fuelwood demand.

Level of Education

Level of education was not significant but had negative relationship with quantity of fuelwood consumed. The negative relationship is consistent with a prior expectation which implies that an attainment of higher level of education might make an individual consume less of fuelwood as a result of accepting alternatives energy sources such as kerosene and cooking gas. Main occupation is positively and not significantly related to fuelwood consumption. The positive coefficient implies that consumers who are fully involved in trading consume more fuelwood than consumers who are civil servant. This explains the greater dependence of traders on fuelwood as the main source of energy for cooking in the study area.

Constraints Militating against the Reduction of fuel wood Consumption

The result presented for the constraints revealed that, majority(71.5%) of the fuelwood consumers indicated low level of income as the major constraint militating against the reduction of fuelwood consumption. Another constraint that militates against the reduction of fuelwood consumption is the high cost of other energy sources like, kerosene and Liquefied petroleum gas (LPG) with (68.5)and was ranked second. The current government policy of deregulation of the oil sector would no doubt skyrocket the prices of other energy source alternative to fuelwood that are environmentally friendly which will consequently result to the reliance on traditional energy sources by most of the consumers in meeting their various energy uses.

Fuelwood consumers (53.5%) responded to lack or non availability of alternative energy sources to fuelwood as another constraint which was third in the ranked. Other consumers (36.5%) indicated large family size as the constraint militating against the reduction of fuelwood consumption. Risk and uncertainty associated with the use of other sources devices was also a constraint as reported by 24% of consumers.

Conclusion

Several researches on fuelwood energy consumption in Nigeria asserted that fuelwood is a major source of consumer's energy. This research also confirms this assertion and establishes that the level of consumption in Kano Metropolis is large as majority 64.5% of domestic consumers depends on fuelwood alone as their major energy source while the remaining others 35.5% combine fuelwood with one form of energy or another.

The major conclusions of this study are that many factors significantly influence fuelwood consumption in the study area. These factors, in general, are some of the socio economic characteristic which includes: age, household size, price of fuelwood, educational status, income level of the respondents and the price of other energy sources. The Price of other energy sources and their accompanied accessories also made the consumption of these energy substitutes to be skewed towards fuel wood and consequently increased its consumption in the study area.

Therefore, with the very high consumption of fuelwood among consumers in Kano Metropolis, consumption of fuelwood can be rated as an important driver of deforestation in the state and Nigeria in general.

Recommendations

- i. There need for a policy that will ensure adequate availability, accessibility, affordability and timely delivery of other energy sources by oil marketers to reduce the fuelwood consumption in the study area.
- ii. The other renewable energy sources, such as solar powered cookers and electricity, should be explored by the consumers to reduce fuelwood consumption.
- iii. There is need for the awareness on safety measures with regard to the handling and utilization of alternative energy sources like LPG and Electricity etc.
- iv. There is the need for creation of more awareness on the disadvantages and effect of excessive fuelwood utilization for personal health and environmental protection.

References

- Ali, I. N. (2013). *Fuelwood and vegetation change in northern Nigeria: An exploration using remote sensing (RS), Geographical Information systems (GIS) and field reports*. A thesis submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy of the University of Portsmouth, UK.
- Anthony, O. O. (2012). Econometric analysis of factors influencing fuel wood demand in rural and peri-urban farm households of Kogi State. Consilience, *The Journal of Sustainable Development*, 8 (1) (2012), 115-127
- Carlos, M.R., & Khang, D.B. (2008). Characterization of biomass energy projects in Southeast Asia. *Biomass and Bioenergy*, 32 (2008) 525-532.
- Ebe, F. E. (2014). *Economic study of fuelwood marketing and consumption in Enugu State, Nigeria*. A Ph.D Research findings presented to the Department of Agricultural Economics, University of Nigeria, Nsukka. August.
- FAO (2008). Forests and energy, key issues, *FAO Forestry Paper 154, Food and Agriculture Organization of the United Nations, Rome*.
- FAO (2005). *Country report-Nigeria: Scenario analysis*. From <http://www.fao.org/docrep/004/AB592E/AB592E00.HTM>
- FAO (1997). Regional study on wood energy today and tomorrow in Asia. *Field Document No.50*. Bangkok, Thailand.
- Foster, A. D., & Rosenzweig, M. R. (2003). Economic growth and the rise of forests. *The Quarterly Journal of Economics*, 118 (2), 601-637. <http://dx.doi.org/10.1162/003355303321675464>
- Inter-Ministerial Committee on Combating Deforestation and Desertification (ICDD) (2000). Report in Nigeria, *Third National Biodiversity Report*. December
- International Energy Agency (IEA), (2006). Energy for all: financing access for the poor – *special early excerpt of the world energy outlook 2011*. OECD/IEA, Paris.
- Smith, K. R. Mehta, S. (2003). The Burden of Disease from Indoor Air Pollution in Developing Countries: Comparison of Estimates. *Int. J. Hyg. Environ. Health*, 206, 279–289.

Appendix

Table 1: Sources of Fuelwood and common tree species used as Fuelwood

Variables	Frequency(200)	Percentage (%)	Ranking
Forest	140	70.0	1 st
Tree plantation	44	22.0	2 nd
Farm land	16	8.0	3 rd
Common tree use for fuelwood			
<i>Anogeissusleiocarpus</i> (Marke)	92	46	1 st
<i>Azadirachtaindica</i> (Maina)	44	22	2 nd
<i>Tamnarindusindica</i> (Tsamiya)	28	14	3 rd
<i>Parkiabiglobosa</i> (Dorawa)	16	8.0	4 th
<i>Prosopis Africana</i> (Kirya)	12	6.0	5 th
<i>Terminal gloucesent</i>	8	4.0	6 th

Source: Field Survey 2015

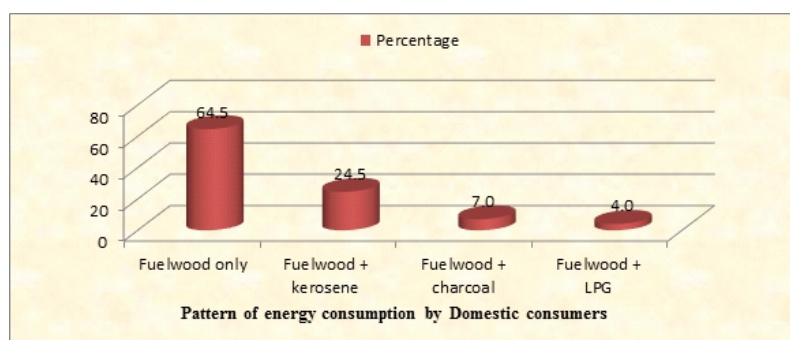


Figure 1: Energy consumption pattern of domestic uses

Table 2: Relationship between socio economics characteristics of domestic consumers and Quantity of fuelwood consumed

Variables	Domestic fuelwood consumption			
	Co-efficient	S.E	t value	Sign
Constant	0.760	19.98	4.624	0.101
Age (years)	0.018	0.026	0.338	0.001***
Household size (No)	0.186	0.162	2.973	0.034*
Monthly Income (₦)	-0.151	0.068	-2.362	0.067*
Education(yrs)	-0.037	0.046	-0.071	0.642
Occupation(Multiple)	0.182	0.067	8.664	0.877
Price of kerosene(₦)	0.322	0.132	5.673	0.021**
Price of fuelwood(₦)	-0.298	0.698	-3.261	0.039**
R ² – adjusted	0.71			
F – value	9.210*			
Sample size	200			

Source: Field survey 2015*** =1%, ** = 5%, * = 10% level of significant

Table 3: Constraints militating against the reduction of fuel wood consumption in Kano metropolis

Constraints	Domestic (n = 200)		
	Frq	%	Rank
Low level of income	143	71.5	1 st
High cost of other energy sources	137	68.5	2 nd
Non availability of other energy source	107	53.5	3 rd
Large family size	72	36	4 th
Risk and uncertainly attached to the use of other energy source	48	24	5 th

Source: Field Survey 2015