DETERMINANTS OF FUEL WOOD CONSUMPTION IN RURAL AND URBAN FARMING HOUSEHOLDS OF KANO STATE, NIGERIA

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ABSTRACT

This research determined the factors that affect fuel wood consumption in rural and urban farming households of Kano State, Nigeria. A total of 258 respondents were interviewed during the data collection. Data were analysed using descriptive statistics and multiple regression. The results revealed that urban dwellers were more educated (50.5%), obtained more income (₦64,426), spent more on non-food expenditures (₦63,000) and stacked fuel wood, unlike rural households who had less tertiary education (7.3%), lower income (₦52,666), and spent less (₦16,000) while using fuel wood only as their source of domestic energy. Multiple regression analysis of the factors affecting rural household consumption of fuel wood had a R^2 adjusted value of 0.642. Education, price of kerosene, household size, nature of cooking, accessibility and gender of household heads were the significant variables affecting fuel wood consumption. On the other hand, the urban households had an R^2 adjusted value of 0.515 for fuelwood consumption; with age and household size being the most significant variables that determined the quantity of fuel wood consumed. Therefore, both rural and urban households need to create more income generating activities to be able to afford clean and superior fuels.

Keywords: Fuel wood; Biomass energy; Farming households

INTRODUCTION

Domestic fuel is one of the necessities of every household. Hence, the choice of domestic fuel for cooking and heating is given adequate consideration when making household economic decision. Household energy consumption refers to the amount of energy resources being used by households on various appliances (Adamu *et al*., 2020). These energy resources include: biofuel and waste, kerosene, electricity, gas, petroleum, diesel, and solar energy (IEA, 2015). Energy is a commodity that is vital for human existence in modern times. In most developing countries, fuel wood has remained the major source of energy for domestic activities. It is the most preferred because of its relative cheapness, availability and traditional beliefs when compared to other energy sources (such as kerosene, gas and electricity) which are expensive, un-common and require some level of education for their use (Audu, 2013).

In Nigeria, fuel wood is a major source of household energy and is also used by small scale industries; with its consumption varying with time and season. Abubakar *et al.* (2010) reported that residential sector energy consumption in Nigeria outweighed other sectors occupying about 65% of the country's total energy consumption. Most households used fuel wood in spite of Nigeria's abundant primary energy resources (such as crude oil, natural gas, coal, tar, sand and solar energy) (Anthony and Angela, 2012). Unfortunately, the use

of fuel wood has been implicated in the high rate of deforestation and degradation in Nigeria. This has also worsened soil conditions causing losses in productive agricultural lands (Wajim, 2020).

People should be encouraged to move up the 'energy ladder' and use cleaner, more efficient fuels, in order to combat the problems associated with the use of biomass especially fuel wood (Suliman, 2011). This would result in the consumption of less fuel per meal, improved health status and lessen the time spent gathering fuel wood. The time gained could be expended on other activities such as attending school or participating in micro projects. Switching to cleaner fuels would increase the opportunities available for women to engage in income-generating activities and improve their livelihoods (Smith *et al.,* 2005; Wilkinson *et al.,* 2007; Yamamoto *et al*., 2009). This study determined the factors influencing fuel wood consumption in rural and urban farming households in Kano, Nigeria. It described the socio-economic characteristics and the problems associated with utilisation of fuel wood in the study area.

MATERIALS AND METHODS

Study Area

Kano is the capital of Kano State (Figure 1), located in the north-western region of Nigeria between longitude 8°W to 10ºW and latitude 11°N to 13°N with an elevation of 488 m above sea level. It has a land area of about 20,131km^2 in Kano metropolis, with an estimated population of 13,076,900 in 2016. Hence, it is one of the largest and among the fastest growing cities in Nigeria. This commercial city is in the Sudan savanna zone with trees, shrubs and scanty grasses. Average annual rain fall is 980 mm. The population density is about 649.6 individuals / km^2, with three agricultural zones namely: Dambatta, Rano and Gaya zones. The economic activities are majorly trading and retailing services, with agriculture mainly at subsistence level. The major environmental problems in the study area are pollution and deforestation/degradation (Olasupo, 2015), while poverty and insecurity are economic problems.

Sampling Technique and Sample Size

A multi-stage sampling technique was used in conducting this research. In the first stage, one rural and one urban local government area was purposely selected from each of the three agricultural zones of the state, due to higher concentration of farmers who were fuel wood users. In the second stage, purposive selection of one ward from the six selected LGAs was done based on higher concentration of fuel wood users. In the urban areas, areas where high-income earners lived were excluded during the selection of the wards. This is because of the limited number of fuel wood users in these areas. In each ward, two communities were selected, hence a total of twelve communities were surveyed. A total sample frame of 783 was obtained (through preliminary survey and some information from the community leaders). The sample frame was subjected to Rao soft (a sample size calculator) where a sample size of 258 was obtained at 95% confidence level. The sampling procedure is summarized in (Table 1). A structured questionnaire was used to elicit information from household heads on the factors influencing fuel wood consumption for domestic energy in the study area.

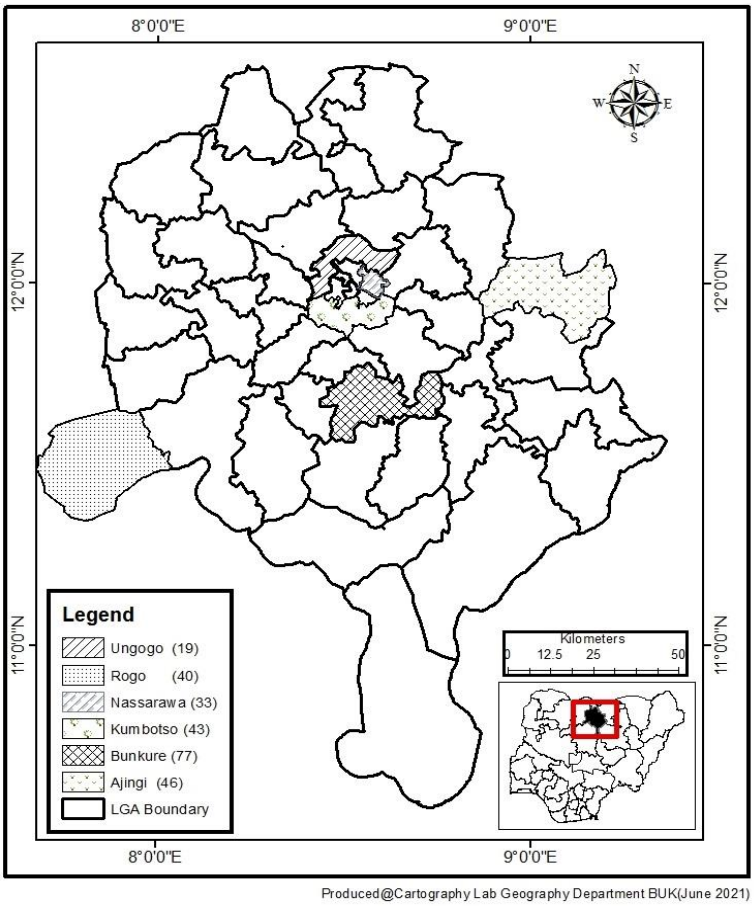

Figure 1. Map of Kano state showing the selected communities (inset: Map of Nigeria)

Table 1. Multi stage sampling procedure for selection of respondents in Kano State, Nigeria

Zone	Local government areas	Ward	Communities	Sampling frame	Sample size
Gaya	Nassarawa	Hotoron-Arewa	Gwarza	49	16
			Mahauta	50	17
	Ajingi	Balare	Makwalla	101	33
			Galadanci	41	13
Rano	Kumbotso	Na'ibawa	Na'ibawa	107	35
			Wailari	25	8
	Bunkure	Sanda	Jigawar-Sanda	103	34
			Sabon Garin-dumari	130	43
Danbatta	Ungogo	Bachirawa	Kwanar-madugu	26	9
			Bachirawa	31	10
	Rogo	Beli	Hago	69	23
			Babbarika	51	17
Total				**783**	**258**

Data Analysis

Descriptive and inferential statistics were used to analyse the data. Patterns of fuel wood utilization as well as the constraints associated with the use of various fuel alternatives were also described.

Multiple Regression Analysis

This model was used to determine the relationship between fuel wood consumption and the factors influencing its use. The rural and urban areas were subjected to regression analysis separately. The model is explicitly expressed as:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \ldots\ldots\ldots\ldots\ldots \beta n + u$…….equation (2)

Where:

Y = Quantity of fuel wood consumed (kg)

β_0 = Constant

β_1- β_n = Regression coefficients

u = error term

X_1 to X_n are the explanatory variables

X_1 = Household income (₦)

X_2 = Education (years of formal schooling)

X_3 = Price of substitute (₦)

X_4 = Age (years)

X_5 = House hold size (numbers)

X_6 = Form of utilisation (1 for home and 0 for non-home consumption)

X_7 = Accessibility (1 for accessible and 2 for fairly accessible)

X_8= Gender of house hold head (1 for male and 2 for female)

Results and Discussion

Socio-Economic Characteristics of Fuel-Wood Users

The socio-economic characteristics of the household heads reflected the variation between the rural and urban areas. Table 2 shows the socio-economic characteristics of the household heads such as age, household size and income.

Men were the household heads in 98.2% and 91.6% of the rural and urban farming households, respectively. The female headed households were those of divorced women or widows living with their children. There was evidence that female-headed households preferred modern fuels to traditional fuels (Farsi *et al.* 2007; Rao and Reddy 2007; Rahut *et al*. 2014). This may be attributed to the fact that women were mostly responsible for household cooking. Thus, they were directly affected by air pollutants emitted during the burning of fuel wood. However, this assertion was challenged by An *et al.* (2002), Ouedraogo (2006) and Abebaw (2007).

The educational level of the household heads, revealed that most of them had some years of formal schooling. An average of 6 years was used for those who attended primary school, only, 12 years for secondary school graduates, and 16 years for tertiary schooling, for both rural and urban household heads. According to the results, only 7.3% of rural dwellers obtained tertiary education which was mostly diploma, while 50.5% of urban household heads had tertiary qualifications. This implied that urban centers had schools and the people had a higher level of commitment to western education. Hence, they are likely to adapt to new changes and make efficient decisions.

The farming households had varieties of agricultural activities ranging from crop, poultry and livestock production. Majority (81.6%) of those in rural households were engaged in crop production (due to their proximity to available lands); 16.6% reared livestock and very few (1.8%) raised poultry, when compared with urban areas, where most of them were poultry producers (78.9%).

Age is a socio-economic variable that affects individual level of thinking, experience and technology adoption (Nmadu *et al.,* 2015). In the rural areas, the age class of 37-56 years had the highest percentage (70%). The minimum and maximum age of the household heads were 27 and 72 years, respectively. For urban households, 62.1% were within age class 47 – 66 years and this revealed the domination of relatively older people in fuel wood utilisation. It could be assumed that older people had larger household sizes and must therefore choose fuel wood because it was cheaper, when compared to other fuels that were either not affordable (liquefied petroleum gas) or not reliable (electricity). The mean ages for both rural (44 years) and urban (46 years) household heads, were within the adoptive age range, implying that they were likely to adapt to other fuel types when available and affordable (Nmadu *et al.,* 2015).

More than 60% of the rural household sizes were between 8 - 19 persons, whereas in urban areas it ranged from 2 - 13 persons. This might be due to the polygamy, which was widely practiced among the rural households. While in the urban areas, monogamy was common. This finding varied from that of Abdulhamid (2016) who obtained a mean household size of 21 among fuel wood users in Kano.

Income comprises all the money available for executing household activities and comprises both on-farm and off-farm income (including primary and secondary occupations). Faisal *et al.* (2013) concluded that there was a positive relationship between fuel type and income levels of households, and this is the basics of energy ladder theory. In Table 2, the mean income of rural households was ₦52,666 (for 12 persons on average) which was not sufficient for meeting the basic food needs and purchase of cleaner fuel for domestic activities. Urban dwellers earned more (₦64,426) and had relatively higher differences in income (with about ₦33,052 as deviation).

Fuel Wood Consumption in Rural and Urban Farming Households

In Nigeria, the proportion of households that consume solid fuels for domestic needs was estimated to be 70% consisting 86% of rural households and 42% of urban households (Gwatkin *et al.,* 2000). The average cost of 1 kg of fuel wood was ₦25 and ₦31 in rural and urban areas of Kano, respectively (Table 3). The weekly consumption was 54.1 kg and 52.03 kg in rural and urban farming households, respectively. The individual annual demand was 234 kg and 300.6 kg, respectively. Yakubu (2014) reported that wood fuel consumption per person was 372 kg $year^{-1}$.

Factors Affecting Fuel Wood Consumption

Rural Areas:

The double-log model was the most suitable for rural areas with R^2 and R-adjusted values of 0.66 and 0.64, respectively. The R-square adjusted implies that 64.2% of the variation in fuel wood consumed was due to the effect of the independent variables (Table 4). The F-value (30.87) was highly significant and reflected the effects of six variables (education, cost of kerosene, household size, nature of food, accessibility and gender of household head).

Table 2. Socio-economic Characteristics of Fuel-wood Users in urban and rural areas of Kano State, Nigeria

	Rural		Urban	
Variables	**Frequency**	**Percentage %**	**Frequency**	**Percentage %**
Sex of household head				
Male	160	98.2	87	91.6
Female	3	1.8	8	8.4
Education				
Qur'anic	29	17.8	12	12.6
Primary	51	31.3	10	10.6
Secondary	71	43.6	25	26.3
Tertiary	12	7.3	48	50.5
Type of farming				
Crop production	133	81.6	7	7.4
Livestock production	27	16.6	13	13.7
Poultry production	3	1.8	75	78.9
Age class				
27-36	37	22.6	15	15.7
37-46	61	37.4	14	14.7
47-56	53	32.6	37	39.0
57-66	10	6.1	22	23.1
67-76	2	1.2	7	7.4
Minimum	3		2	
Maximum	26		25	
Mean	12		9	
Standard deviation	6.2		6.3	
Income (₦)				
15000-44000	34	20.9	14	14.7
45000-74000	78	47.9	18	18.9
75000-104000	40	24.5	31	32.7
105000-134000	9	5.5	27	28.4
135000-164000	2	1.2	5	5.3
Minimum	15,000		22,000	
Maximum	130,000		163,000	
Mean	52,666.46		64,426.32	
Standard deviation	26,196.6		33,052.5	

Table 3: Consumption of Fuel Wood in Rural and Urban Farming Households of Kano State, Nigeria

Consumption	**Quantities (Kg)**	
	Rural	**Urban**
Daily/Household	7.7	7.4
Weekly/Household	54.1	52.0
Annual/Household	2813.2	2705.5
Annual/ Individual	234.0	300.6

The effects of some variables were positive, while that of others were negative.

Educational status was significant at $p \leq 0.05$ and inversely related to the dependent variable, implying that for every one year increase in years of formal schooling, there was a tendency that the quantity of wood consumed would reduce by 0.134 kg. The educated household heads were likely to consume less fuel wood and more superior fuels (Nlom and Karimov, 2014; Abdulhamid, 2016; Danlami, 2019).

Household size was significant and had a positive coefficient. This agreed with Pandey and Chaubal (2011), as well as, Ozcan *et al.* (2013) who indicated that larger households preferred dirty fuels over clean ones. One possible reason could be that poorer households have larger household sizes. A unit increase in the size will lead to an increase in wood demand by 0.53 kg. In addition, an increase in the size of the household without an increase in the earning of the household head means more responsibility. The nature of food implied whether the households cook and sell food, thus requiring more energy and were likely to burn more fuel wood.

The accessibility of the fuel was another factor that was found to be positive and highly significant (at $p \leq 0.01$). Those in rural areas had more access to farms and nearby forest for fuel wood collection. Where there were no forests, fuel wood was accessible in nearby markets. Gender of the household head was negatively significant at $p \leq 0.05$ and implied that male headed households preferred to use fuel wood than female headed households. This might be as a result of its availability on most farms. Hence, male headed households used fuel wood more than female headed households. Ages and income were not significant variables and this suggested that rural farming households in Kano used dirty fuels, irrespective of their incomes. Here are examples of places where the theory of energy ladder may not hold. This is similar to the findings of Mehkonnen and Kohlin (2009), who examined the determinants of household fuel choices in major cities of Ethiopia and found that fuel stacking theory was more suitable than energy ladder.

Urban Areas

In urban areas of Kano State, the estimated semi-log regression model was the most suitable model. The effect of household income was highly significant (at $p \leq 0.05$) and inversely related to quantity of fuel wood consumed. This finding shows the effect of income unlike in the rural areas of Kano. Abubakar (2010) opined that there was a significant and inverse effect of income, when it comes to choice of domestic fuel for cooking in the energy ladder. Educational level of the household head was significant (at $p \leq 0.05$) and negatively influenced by the dependent variable. With every one year increase in formal schooling, there was a tendency of reduction in the quantity of fuel wood consumed by 0.005% (Ouedraogo, 2006; Demurger and Fournier, 2011; Nlom and Karimov, 2015; Abdulhamid, 2016).

Liquid petroleum gas was a major substitute of fuel wood in urban areas of Kano. Electricity was not included as a wood substitute because the supply of electricity in the urban areas was inadequate and unreliable. Age of the household head was significant at 1% and agreed with the research of Baiyegunhi and Hassan (2014) who found that an increase in the age of household heads induced a shift away from natural gas towards fuel wood in Nigerian households. Other similar

results include that of Rahut *et al*. (2014) and Edwards and Langpap (2005).

Problems Associated with Fuel Wood Utilisation

Even though, fuel wood is the most consumed fuel adopted among Nigerian households, its utilisation is facing problems ranging from external and internal attributes of the fuel. It was observed that 60.1% and 66.3% of both rural and urban households disliked the smoky nature of fuel wood (Table 5). The smokiness makes cooking with fuel wood very tedious, especially, during rainy season, when the relative humidity is high. Some of the problems depend on location and income of the users. In rural areas where income level is relatively low, 20.9% complained that wood was becoming costly and inaccessible to children who collect them from nearby farms.

CONCLUSION AND RECOMMENDATIONS

Wood remained the most recognized and common fuel in the study area. Fuel wood consumption did not only depend on income, but on factors such as larger household sizes and low level of education. Therefore, households need to create more income generating activities in order to increase their purchasing power and access to cleaner fuels. Furthermore, government should ensure adequate supply of other substitutes of fuel wood such as electricity.

Table 5: Problems Associated with Fuel Wood Utilization in Rural and Urban Areas of Kano State, Nigeria

Variables	Rural (n=163)		Urban (n=95)	
	Frequency	Percentage %	Frequency	Percentage %
Smoke	98	60.1	63	66.3
Dirt	21	12.9	9	9.4
In-accessibility	10	6.1	18	18.9
Costly	34	20.9	3	3.1
Low thermal efficiency	0	0	2	2.1

Table 4: Factors Affecting the Quantity of Fuel Wood Consumed in Kano State, Nigeria

	Rural				Urban			
Variables	**β**	**Standard error**	**t-value**	**Sig.**	**β**	**Standard error**	**t-value**	**Sig.**
Constant	-6.377	3.879	-1.644	0.103	1.650	0.116	14.168	0.000
Income	0.019	0.041	0.462	0.645	-0.800	0.000	-2.317	0.023**
Education	-0.134	0.058	-2.305	0.023**	-0.005	0.002	-2.022	0.046**
Cost of Kerosene/LPG	-2.984	1.563	-1.910	0.058*	-0.283	0.075	-4.011	0.078*
Age	-0.053	0.103	-0.515	0.608ns	0.004	0.001	3.332	0.001***
Household size	0.526	0.043	12.341	0.000***	0.008	0.002	3.362	0.001***
Nature of food	0.294	0.156	1.884	0.062*	0.054	0.036	1.519	0.132ns
Accessibility	0.125	0.038	3.292	0.001***	0.003	0.023	0.116	0.908ns
Gender	-0.581	0.226	-2.574	0.011**	-0.005	-0.040	-0.135	0.893ns
	R^2 = 0.664				R^2 = 0.551			
	R^2 Adjusted = 0.642				R^2 Adjusted =0.515			
	F Value = 30.87				F Value = 15.267			
	F Probability = 0.000				F Probability = 0.000			

*** = significant @ 1% ** = significant @ 5% * = significant @ 10%

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