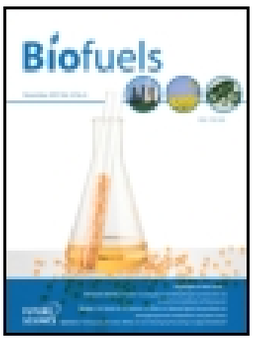


Biofuels

ISSN: 1759-7269 (Print) 1759-7277 (Online) Journal homepage: http://www.tandfonline.com/loi/tbfu20

From biomass cooking fuel source to modern alternative for Bauchi State households: a preliminary analysis

Abubakar Hamid Danlami, Shri-Dewi Applanaidu & Rabiul Islam

To cite this article: Abubakar Hamid Danlami, Shri-Dewi Applanaidu & Rabiul Islam (2016): From biomass cooking fuel source to modern alternative for Bauchi State households: a preliminary analysis, Biofuels, DOI: 10.1080/17597269.2016.1226724

To link to this article: http://dx.doi.org/10.1080/17597269.2016.1226724

Published online: 09 Sep 2016.

BIOFUELS, 2016
http://dx.doi.org/10.1080/17597269.2016.1226724

Taylor & Francis
Taylor & Francis Group

From biomass cooking fuel source to modern alternative for Bauchi State households: a preliminary analysis

Abubakar Hamid Danlami, Shri-Dewi Applanaidu and Rabiul Islam

School of Economics, Finance and Banking (SEFB), College of Business (COB), Universiti Utara Malaysia (UUM), 06010 Sintok, Kedah, Malaysia

ABSTRACT

Biomass as the source of cooking fuel is one of the causes of indoor air pollution, desertification, soil erosion and other visual problems. The main aim of this study is to carry out a feasibility analysis in order to ascertain the possibility of conducting a study on the factors influencing household cooking fuel choice in Bauchi State. A total of 30 households were chosen systematically from the study area. A logit regression model was used to analyse the data. Cronbach's alpha value of 0.71 shows good reliability and acceptability as a valid study. Therefore, a study to analyse the determinants of household cooking fuel choice in Bauchi State is feasible and may provide conclusions relevant for policy making. Logit results show that income, number of rooms and nature of the home building are the variables that are positively related to the odds of adopting modern cooking fuel sources. Age of household head, gender of household head and home appliances are negatively related to the odds of adopting modern cooking fuel sources. Therefore, appropriate relevant policies will encourage households to adopt modern sources of cooking fuels.

ARTICLE HISTORY
Received 1 May 2016
Accepted 9 August 2016

KEYWORDS
Biomass; cooking; fuel; households; Bauchi

Introduction

Bauchi State is the most populous state with low efficient energy use in Nigeria [1]. There is wide use of firewood as the main source of fuel for many households in Bauchi State, especially for cooking purposes. Available data have shown that the average rate of clean fuel use in Bauchi State is far lower than the national average. The rate of household fuel wood use (for cooking purpose) in Bauchi State, Nigeria, is more than 90%, far higher than the urban national average of about 40% and the whole national average of about 70% [1].

Figure 1 shows the categories of selected households and their main source of cooking fuel in Bauchi State, Nigeria. About 43% of households use fuel-wood solely as their source of cooking fuel, while the majority of the households combine both fuel-wood and fossil fuels to source energy for cooking purposes. Furthermore, the average consumption of firewood per household in Bauchi State is more than 600 kg/month, mainly sourced from forest reserves, friends' farmlands or bought from the market [2]. It is argued that the monthly quantity supply of firewood per person in Bauchi State is about 750 kg [3]. Most of these fuel-woods are sourced from the chosen preferred trees (among the available trees in the state) such as Madobiya, Kirya, Baushe and Marke mainly due to availability, efficiency, affordability and cultural reasons [2,4].

The rampant use of firewood as a fuel source for the majority of the households has posed negative impacts to the inhabitants of the state. The first negative impact of firewood as the main source of cooking fuel in Bauchi State is the systematic destruction of the state's forest reserves and woodlands [3]. Environmental problems in the state such as soil erosion and the persistent desertification are the consequences of felling of trees. The Bauchi State government argued that the state loses on average one kilometre of land area yearly, because of desertification mainly caused by the high rate of felling trees for cooking fuel and other relevant uses [5]. The total estimated deaths due to indoor air pollution related diseases as a result of the high rate of biomass fuel use is 3500 per year [1].

Therefore, analysing the patterns of household energy use in Bauchi State can enable the relevant authorities to have a clear picture and understand the factors that can shape the pattern of household energy choice in the state in order to encourage the households to adopt cleaner energy sources. This contributes to the process of government efforts in the attempt to curtail the excessive and mass use of firewood as the major source of household fuel energy in the state.

Moreover, this study is further motivated by the inconsistencies and conclusions of previous studies on household energy use. For instance, some studies [6–8] found that income has a positive significant relationship with household use of firewood. Other studies

CONTACT Abubakar Hamid Danlami sadiqdanlami2@gmail.com

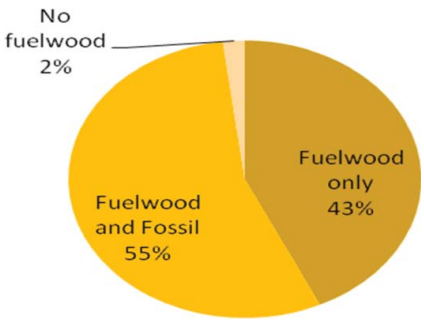


Figure 1. Categories of households by fuel sources in Bauchi State, Nigeria. (Source: Modified from [2]).

[9–11] found the relationship to be negative. Couture et al. [12] and Jingchao and Kotani [13] concluded that there is no significant relationship between income and household firewood consumption.

Variables like age of the household head, level of education of the household head, household size, occupation, and size of the dwelling were concluded to be positively related to household firewood consumption by Nnaji et al.,[14] Ganchimeg and Havrland [15] and Onoja [10]. However, Song et al.,[11] Heltberg [16] and Jingchao and Kotani [13] found these relationships to be negative. Additionally, some studies such as Jumbe and Angelsen [17] and Laureti and Secondi [18] concluded that there is no significant relationship that exists between these variables and household fuel-wood consumption. The same case applies to other sources of household energy such as kerosene, electricity and LPG; some studies [19,20] concluded a positive relationship, some [21–23] found a negative relationship and others [24] found no relationship. Thus, results and findings of studies on households' cooking fuel use carried out in one area cannot be generalised to other areas, due to heterogeneity in the pattern and styles of household fuel consumption from one area to another. Hence, this study on household cooking fuel choice adoption in a new area under a consideration is a contribution to the existing body of knowledge.

Review of the related literature on the determinants of household cooking fuel choice and consumption

This section examines the factors that influence the level of household fuel choice and consumption. Each of these factors is expected to relate to the quantity of fuel consumption of households either positively or negatively.

These factors include disposable household income, age, gender composition in the household, gender of the household head, education, occupation, marital status, home ownership, household size and number of children. Others factors are location, cooking habit, availability of fuel alternatives and accessibility, cooking utensils, wage labour market, house type, number of rooms and size of residence [15,25,26,27–29]. Normally, the extent and the dimension of how these factors influence household energy adoption and consumption varies from area to area and also from one type of fuel source to another.

What follows is an explanation of different categories of factors influencing household fuel choice and consumption.

Economic factors

These are the factors that serve as a measure of economic status of households which can influence the households' cooking fuel consumption decision. The variables include household income, occupation of the household head, home ownership, fuel cost and the prices of the end use technology. For instance, studies have established that there is a positive relationship between income and adoption of modern clean energy [12,13,30–32]. Poorer households, especially in developing countries, tend to adopt firewood, plant residues, animal dung and other biomass cooking fuels, whereas wealthier households tend to adopt cooking fuel from modern sources like electricity and gas.

A relationship also exists between the type of occupation of the household head and the nature of the cooking fuel source to be adopted by the household. Empirical studies conducted by Eakins,[33] Ozcan et al. [31] and Heltberg [16] proved that those in white collar jobs (executives, entrepreneurs) tend to adopt modern clean fuels, while those in blue collar jobs (such as farming and trading) tend to adopt firewood and other biomass fuels. Home ownership, which is also one of the indicators of the economic status of households, affects their decision on the type of cooking fuel sources to adopt. Those who live in an owned house adopt clean cooking fuel sources as established by previous studies [12,18]. The price of fuel has a negative relationship with fuel consumption. When the price of a particular fuel source is high, households switch to other alternative fuels available; this is in line with law of demand and also has been established by so many previous studies [6,7,13,15,32].

Socio-demographic factors of households

The type and composition of socio-demographic factors of households influence their cooking fuel switching and consumption behaviour. These factors include marital status, gender, level of education and age of the household's head, gender composition in the household (female/male ratio), and size of the household. Nlom and Karimov,[7] Jumbe and Angelsen,[17] Osiolo,[32] Suliman [34] and Mekonnen and Kohlin [9] found no significant relationship between the gender of the household head and its cooking fuel

consumption behaviour. However, Mensah and Adu [30] found that households tend to adopt clean energy when the head of the household is female. Age of household head was found to have a negative relationship with the adoption of clean fuel [7,30,34]. Households adopt biomass fuels when the head is older. Level of education of the household head has a positive relationship with clean fuel adoption. The higher educated is the household head, the more he realises the negative impact of biomass fuels and therefore the less it will be adopted. This assertion was found to be true by many studies [7,16,18,30,31,33,34].

As the ratio of female to male members of the household increases, the household adopts biomass cooking fuel sources. This statement was supported by previous studies [16,34]. Household size also affects the household's decision on the type of cooking fuel to adopt; the larger the size of a household, the less the possibility of adopting a modern source of cooking fuel. This assertion was supported by many studies [13,16,18,30,31,34]

Home characteristics

The characteristics of the building in which the households live also affect their energy choice behaviour. Factors such as location of the house, nature of the house, the size of the residence, number of rooms in the house, share of dwellings (i.e. more than one household living in the same building), as well as the period when the home was built have a significant influence on household fuel consumption. For instance, the location of the home has a serious impact on fuel consumption decisions. Households that are located in urban areas adopt more clean fuel than their rural counterparts. This was proved to be true by Eakins,[33] Ozcan et al. [31] and Mensah and Adu [30].

In addition, the type of house (i.e. nature of the building) exacts some influence on household fuel use behaviour. For instance, Eakins,[33] Ozcan et al. [31] and Laureti and Secondi [18] empirically found that living in a detached house has a significant positive relationship with the adoption of gas, electricity and liquid fuel. The sizes of the residence in which households live also influence their energy consumption behaviour. Couture et al.,[12] Laureti and Secondi [18] and Song et al. [11] found that the larger the size of the building, the higher the adoption of fuel wood, all other variables being equal.

Furthermore, the number of rooms in the house is one of the building characteristics which influences households energy consumption choice. Eakins [33] and Heltberg [16] found this variable to have a positive significant relationship with the household use of Liquefied Petroleum Gas (LPG). Share of dwellings (i.e. more than one household living in the same building) is one of the factors which also shape the fuel consumption behaviour of households. Couture et al. [12] found that this factor has a positive relationship with the adoption of modern clean fuel.

Environmental and exogenous factors

Another important category of factors that influence fuel choice are the exogenous factors. These are the factors which lie outside the domain of households but have effects on the household fuel choice. These include physical environment, energy policies and regulations and availability. The physical environment such as the level of organisation and development of the fuel market, temperature of the weather, the specific country context and where it is located, affect the fuel consumption behaviour. Furthermore, the level of urbanisation plays a positive impact on clean energy adoption [35]. Change of climate temperature has also been shown to have an influence on household fuel adoption.

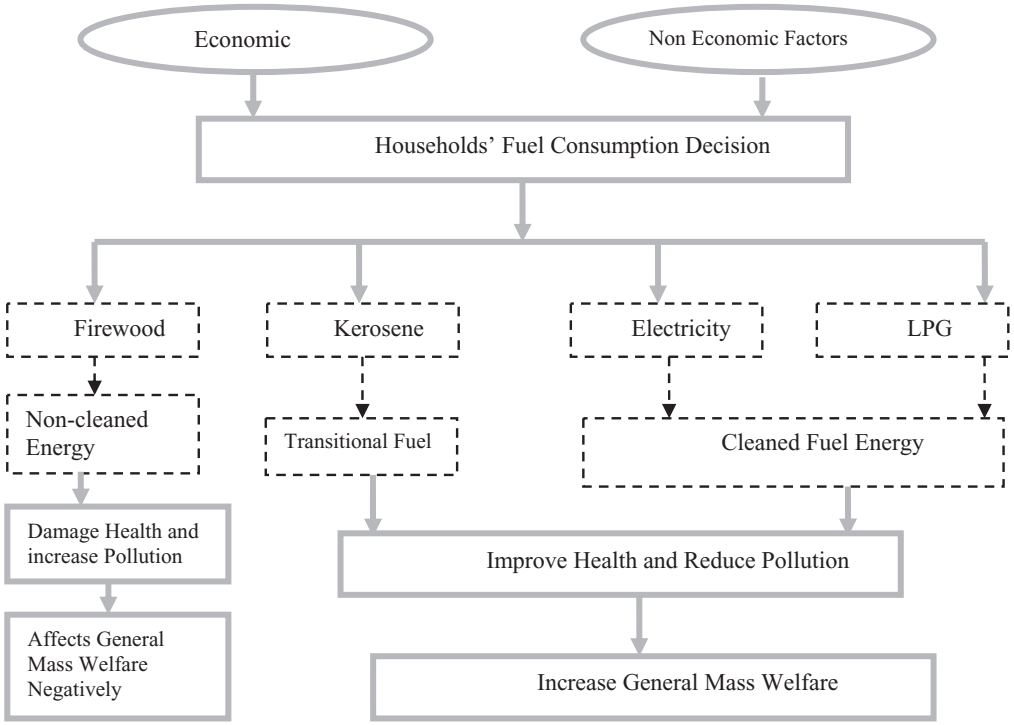
Moreover, availability of a particular fuel source can affect household behaviour of fuel adoption. Households often choose a fuel source that is cheaper and nearer for consumption purposes. Empirically, Mensah and Adu [30] found a positive relationship between household fuel consumption and the availability of the concerned fuel. Heltberg [36] argued that if households have access to cheap electricity, the consumption of traditional biomass as the major cooking fuel choice decreases.

Based on the reviewed determinants of cooking fuel choice, the conceptual frame for the determinants of household fuel choice is shown as follows:

Figure 1 shows how fuel consumption decision is affected by economic and non-economic factors. Economic factors may include market price of fuel, household income, and household expenditures; non-economic factors may include a set of household characteristics such as household size, gender, education, home ownership, type of dwelling, location of residence and the distance to fuel source. The outcome and the implication of this behaviour may be improved health and reduced pollutions if a clean fuel is chosen, which is a reflection of public welfare improvement. However, where the decision of household fuel consumption falls on non-clean energy, the result may be damaged health and increased pollution which in turn negatively affect general societal welfare.

Materials and methods

Because this paper is a study of households at the micro level, this section contains the description of the methods used in data gathering as well as the model used by the study as the tool of data analysis.



Source: Danlami et al.[37]

Sampling and data source

Being a pilot study, the total sample size utilised in this study is 30 households. The questionnaire method was used as the instrument of data collection. This instrument was used because it is an easy and cheap means of gathering data from the targeted respondents.

Model specification

Since households have a choice of either adopting biomass cooking fuel or otherwise, a logit regression model was used to analyse the expected impacts of the variables on the household adoption of biomass cooking fuel in Bauchi State, Nigeria.

Following Gujarati [38] the theoretical logit model can be expressed as:

$$P = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 X_i)}} \tag{1}$$

For ease of expression if $z = \beta_1 + \beta_2 X_i$ then:

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{e^z}{1 + e^z} \tag{2}$$

If P represents the probability of occurrence (say adopting modern source of cooking fuel), the probability of not occurrence can be expressed as:

$$1 - P_i = \frac{1}{1 + e^{z_i}} \tag{3}$$

Hence the odds ratio between the probabilities of occurrence and non-occurrence can be expressed as:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \tag{4}$$

Where $P_i/(1\text{-}P_i)$ represents the odds ratio of adopting modern source of cooking fuel. That is the ratio of the probability that a household will adopt a modern source of cooking to the probability of otherwise. Taking the natural log of equation (4) we obtained the following expression as:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = Z = \beta_1 + \beta_2 X_i \tag{5}$$

Where L means the log of odds ratios, equation (5) represents what is known as the logit model which is used when the dependant variable takes a binary value; 0 or 1.

The empirical logit model estimated in this study can be expressed as:

$$\ln\left[\frac{P_i}{1 - P_i}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \tag{6}$$

Where P_i is the probability that a household adopts modern fuel source for cooking and $P_i/(1\text{-}P_i)$ is the

odds of adopting modern cooking fuel in relation to the adoption of biomass cooking fuel sources. βs represent the various coefficients of the model and the Xs are the variables to be estimated. A logit model has been used by many previous studies of household behaviour [39,41]. Table 1 shows the descriptive statistics of the variables analysed in the model.

Table 1 contains the summary statistics of the variables used in this study. The data were sourced from the field survey of 30 households conducted in Bauchi State, Nigeria in June 2015.

Tables 1 and 2 contain the descriptive statistics of the variables and the socio-economic characteristics of the respondents. The average monthly income of the respondents is about ₦60,000 (US$187) which is higher than the income range earned by most of the respondents as indicated in Table 2. This reflects the poverty situation of many households in Bauchi State, Nigeria. The majority of the respondents are teachers, tailors, welders and mechanical workers. The majority of the respondents use firewood as their main source of cooking fuel mostly due to affordability, availability and low income. Bauchi State is one of the most populous states with a high rate of firewood use as the main source of cooking fuel [42]. None of the respondents claim to use gas as their main source of cooking fuel.

Table 3 indicates the extent and the magnitude of relationships that exist among the variables used in this study. Table 3 indicates that most of the variables are weakly correlated. In other words, there is a weak relationship between the variables. Except the relationship between household size (HHS) and HHS^2, whereby the relationship between these two variables is very high, though not surprising because HHS^2 is a square of HHS. This implies that the variables considered in the estimated models are not measuring the same phenomena. In other words, we can conclude that there is an absence of high multicollinearity among the variables. Therefore, all variables were included in the estimation of household fuel choice models.

Table 1. Descriptive statistics of variables.

Variables	Number	Means	Deviation	Minimum	Maximum
Cooking fuel main source	30	0.37	0.49	0	1
Gender	30	0.80	0.41	0	1
Age	30	37.50	13.12	23	60
Marital status	30	0.73	0.45	0	1
Home appliances	29	19.55	13.94	5	73
Neighbours cooking fuel source	30	0.53	0.51	0	1
lnHomesize	30	3.92	0.37	3.00	4.70
Household size	25	11.8	5.92	2.00	28.00
lnHouseholdsize^2	25	5.74	2.51	0.48	11.10
Income (US$)	30	187.24	132.47	50.00	400
Number of rooms	30	5.70	2.58	2	11
Home nature	29	2.72	2.15	0	7

Note: Home nature refers to the type of the building in which the household lives, which can be in different forms such as; traditional home, single/ semi detached home, row house, apartment in a duplex/building and single attached house.

Table 2. Socio-economic characteristics of households in Bauchi State.

Characteristics	Frequency	Percentage	Cumulative Frequencies
Gender			
Male	24	80	80
Female	6	20	100
Age			
16–30	8	26.66	26.66
31–45	14	46.67	73.33
46–60	7	23.33	96.67
Above 60	1	3.33	100
Marital Status			
Single	8	26.67	26.67
Married	22	73.33	100
Level of Education			
Non-formal Education	1	3.33	3.33
Primary School	0	0.00	3.33
Secondary	7	23.33	26.67
Diploma/NCE	11	36.67	63.33
BSc/HND	6	20.00	83.33
Postgraduate	5	16.67	100
Occupation			
No standard job	4	13.33	13.33
Farmer	3	10.00	23.33
Teacher	7	23.33	46.67
Lecturer	2	6.67	53.33
Businessman	6	20.00	73.33
Others	8	26.67	100
Monthly Income			
below US$100	11	36.67	36.67
US$100–US$200	6	20.00	56.67
US$201–US$300	3	10.00	66.67
US$301–US$400	5	16.67	83.33
Above US$400	5	16.67	100
Main source of cooking fuel			
Firewood	19	63.33	63.33
Kerosene	10	33.33	96.67
Electricity	1	3.33	100

Table 3. Correlation analysis of variables.

GEND	AGE	MSTA	HAPS	NCFL	HMSZ	HHSZ	$HHSZ^2$	INC	NRM	HNAT
GEND	1.00									
AGE	0.27	1.00								
MSTA	0.45	0.63	1.00							
HAPS	-0.31	0.10	0.41	1.00						
NCF	0.03	0.04	0.40	0.06	1.00					
HMSZ	-0.27	-0.15	-0.25	0.67	0.01	1.00				
HHS	-0.03	0.13	-0.22	0.43	-0.35	0.31	1.00			
HHS^2	-0.08	0.19	-0.22	0.40	0.34	0.29	-0.98	1.00		
INC	-0.13	0.14	0.05	0.36	0.13	0.41	-0.15	-0.12	1.00	
NRM	-0.16	-0.22	-0.37	0.57	-0.22	0.67	0.39	0.40	0.02	1.00
HNAT	0.01	-0.10	-0.12	-0.09	-0.29	-0.21	-0.01	-0.05	-0.25	-0.21	1.00

Note: GEND = Gender; AGE = Age; MSTA = Marital status; HAPS = Home appliances; NCF = Neighbourhood Cooking Fuel; HMSZ = Home size; HHS = Household size; HHS^2 = Household size square; INC = Income; NRM = Number of rooms; HNAT = Home nature.

Results and discussions

In order to assess the validity of the variable items that are considered by this pilot analysis to be related to the adoption of household cooking fuel source in Bauchi State, the coefficient of Cronbach's alpha was estimated using STATA software. Cronbach's alpha describes the extent to which variables measure a concept. It is connected to the inter-relationship of the variables in the test. According to Santos [43], Cronbach's alpha examines the average correlations of variables in a survey instruments to gauge its reliability. The value of Cronbach's alpha ranges between 0 and 1, the closer the value is to 1 the better the result. Gliem and Gliem

Table 4. Cronbach's alpha values of variables related to household cooking fuel.

ITEMS	OBSERVATIONS	ALPHA
Gender	30	0.7136
lnAge	30	0.7147
Marital Status (mstatus)	30	0.7133
Education	30	0.7128
Household Size (Hhsize)	25	0.6926
Occupation	30	0.7091
lnIncome	30	0.7105
Homeownership	30	0.7132
Homesize	30	0.6707
$lnHomesize^2$	30	0.6749
Number of rooms (Nrooms)	30	0.6884
Dwelling-share	30	0.7161
Home nature	29	0.7114
Cooking fuel main source	30	0.7138
Neighbourhood cooking fuel source (Ncfuel)	30	0.7157
Home appliances	29	0.5932
$lnHome\ appliances^2$	29	0.6666
lnfirewood-quantity	17	0.7112
lnKerosene-quantity	19	0.7116
lnUnit-price-firewood	18	0.7077
lnUnit-price-kero	16	0.7099
Test Scale		**0.7127**

[44] posit that any value of a Cronbach's alpha below 0.5 is unacceptable. Moreover, Santos [43] agrees that any value of Cronbach's alpha from 0.7 is acceptable though lower threshold values are used in the literature sometimes. Table 4 contains the result of the estimated Cronbach's alpha for this pilot study.

From Table 4, the average calculated Cronbach's alpha value is 0.71. This shows that the data to be obtained on the variables included in this pilot study may be good, reliable, and acceptable for a valid study and analysis on household cooking fuel adoption in Bauchi State, Nigeria.

Moreover, this paper utilises a logit model to examine the result of the assessment of some factors influencing households' adoption of cooking fuel in Bauchi State, Nigeria, which may serve as an exploratory analysis for the mother analysis. Table 5 contains the results of the estimated models.

The results of the estimated odds ratios for the various models are shown in Table 6.

Table 5 contains the results of the estimated logit models based on the pilot data. Table 5 contains five different logit models, consisting of different combinations of variables. This is because the total sample size is only 30, therefore the available observations are also 30 and there are many variables that are expected to have influence on household cooking fuel sources. Only 3 or 4 variables are included in each model for the estimation to be possible and also to comply with Roscoe [45] and Sekaran [46] that a sample size that is as ten times as the number of variables is accepted for a multivariate regressions. Bartlett et al. [47] argued that the rule of thumb for the accurate sample size of at least 5 to 10 times larger than the number of variables.

Gender: This variable represents the gender of the household head which takes a binary value, 1 for male, otherwise 0. This variable was found to have a negative relationship with the households odds of adopting non-biomass cooking fuel. This implies that a household who is headed by a female has higher odds of adopting modern cooking fuel by more than 3% compared to a male-headed household. This is because normally females are in charge of cooking food at home in Bauchi State, and they suffered more when using biomass cooking fuel, thus they wish to adopt modern cooking fuel sources which are cleaner. This variable was found to be statistically significant at 10% level. This finding corresponds to the findings of Mensah and Adu [30].

Age: This variable represents the age of the household head measured by number of years. This variable

Table 5. Results of the estimated logit models.

VARIABLES	MODEL1	MODEL2	MODEL3	MODEL4	MODEL5
Gender	-1.310343		−3.134219*	−3.754188*	
	(1.286876)		(1.660827)	(2.249242)	
Age	−.1501135**				
	(.0716169)				
Marital Status	3.734502**				
	(1.659571)				
Home Appliances		−.1845982***			
		(.0681308)			
Ncfuel		−1.123905			
		(.9559574)			
lnHomesize		3.040426*			
		(1.591197)			
Hhsize			−4.661921*	3.16093**	−.5004676**
			(2.511335)	(1.588318)	(.1964245)
$lnHhsize^2$			7.74999*	−.2398706**	
			(4.375664)	(.1157607)	
Income				.0000279*	−2.232116
				(.0000164)	(1.450182)
Nrooms					.9234719*
					(.4847863)
Home nature					.8636981
					(.4502023)
Constant	3.256363*	−8.809357	8.147866**	−5.397749	20.72658
	(1.978092)	(5.57734)	(3.839492)	(4.311574)	(13.73277)
Pseudo R^2	0.25	0.23	0.50	0.55	0.49

Note: standard errors are in parenthesis while the asterisks *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

Table 6. Estimated odds ratio of the determinants of cooking fuel adoption in Bauchi State, Nigeria.

VARIABLES	MODEL1	MODEL2	MODEL3	MODEL4	MODEL5
Gender	0.152		0.0309*	0.0263*	
	(0.215)		(0.0551)	(0.0504)	
Age	0.902**				
	(0.0449)				
mstatus	39.90**				
	(70.74)				
Home appliances		0.831**			
		(0.0764)			
Ncfuel		0.325			
		(0.300)			
lnHomesize		20.91			
		(40.78)			
HHS			5.7725	17.21*	0.689***
			(6.4311)	(27.93)	(0.0883)
Income				1.003	0.997
				(0.00211)	(0.00185)
HHS^2			0.86533*	0.806*	
			(0.0705)	(0.0911)	
Nrooms					1.266
					(0.308)
homenature					1.708*
					(0.509)
Constant	7.043	0.000149	3,456**	0.0102	3.892
	(10.58)	(0.000989)	(13,269)	(0.0526)	(8.207)
Observations	30	29	25	25	24

Standard errors (e-form) in parentheses *** $p < .01$, ** $p < .05$, * $p < .1$

was found to be statistically significant at 5% level and was also found to be negatively related to the odds of adopting modern cooking fuel source by households. As the household head becomes older by 10 years, the odds of adopting modern cooking fuel source reduces by about 15%. This finding conforms to a priori expectations because when people use a commodity for a long period of time, they find it difficult to change the pattern of their consumption when they become older. This finding conforms to the findings of previous studies [7,30,34].

Marital Status: This variable means the marital status of the household head. This variable is a dichotomous variable coded as 1 for a married household head otherwise 0. Based on the result of the estimated logit model, this variable was found to be statistically significant at 5% level and was also found to have a positive relationship with the household odds of adopting modern cooking fuel. A household headed by a married individual has a chance of adopting modern cooking fuel three times higher than otherwise, all things being equal. This is because individuals get married when economically strong, and being economically strong means the chance of avoiding biomass cooking fuel is higher.

Home Appliances: This variable represents the number of energy using devices such as fans, air conditioners, refrigerators and others, possessed by the household that are used at home. This variable is measured by the unit quantity of these items possessed at home. Based on the result of the estimated logit model, this variable was found to be statistically significant at 1% level and also was found to have a negative relationship with the adoption of modern cooking fuel sources. A one unit increase in energy consumption devices at home reduces the odds of adopting modern cooking fuel by about 0.18 units all things being equal. This conforms to the findings of some previous studies [48].

lnHomesize: This variable represents the size of the house in which the households live, measured by the number of feet of the plot size in which the house is built. This variable was found to be statistically significant at the 10% level and was found to have a positive relationship with the adoption of modern cooking fuel sources. The larger the home size, the higher the odds of adopting a modern source of cooking fuel all things being equal. This finding contradicts the findings of other previous studies [12].

Household Size: This variable represents the number of individuals per head in the family. In other words, it refers to the size of the family. This variable was found to be statistically significant at the 5% level and was found to have a negative relationship with the odds of adopting modern cooking fuel sources. When the number of family members is large the odds of adopting a modern source of cooking fuel decreases. This conforms to a priori expectation and is also in line with the findings of previous studies [17,30,31]. Furthermore, the square of this variable was also estimated in order to ascertain the extent of the non-linear relationship that may exist between household adoption of modern cooking fuel and the household size; it was also found to be statistically significant at the 5% level.

Income: This variable represents the total monthly income of the household measured in Naira. This variable was found to be statistically significant at the 10% level. Based on the result of the estimation this variable has a positive relationship with the odds of adopting modern cooking fuel, when the income increases households adopt modern cooking fuel instead of biomass fuels. This conforms to a priori expectation and is in line with the findings of Mensah and Adu,[30] Ozcan et al. [31] and Couture et al [29].

Number of Rooms: This variable represents the number of rooms in the house in which the household lives. This variable is statistically significant at the 10% level and was found to have a positive relationship with the odds of adopting modern cooking fuel. This is in line with the findings of Eakins [33] and Heltberg [16].

Conclusions and recommendations for future studies

This paper is a preliminary analysis conducted to examine the determinants of household cooking fuel choice in Bauchi State, Nigeria. Being a preliminary study, the main aim is to carry out a feasibility analysis of the pilot data obtained in order to ascertain the possibility of conducting another study on the factors influencing

household cooking fuel choice in the study area. Based on the estimated Cronbach's alpha coefficient, the results show that a full study on household adoption of cooking fuel source using the same variables as used in this pilot study may produce a good, reliable, accepted and valid study. Hence a study to analyse the determinants of household cooking fuel choice in Bauchi State is feasible, worth conducting and may likely discover a valid conclusion that may benefit the people of Bauchi State, Nigeria.

Furthermore, the estimated logit regressions based on the pilot data show that marital status of the household head, income, number of rooms, nature of the home building and size of the house are the variables that are significantly and positively related to the odds of adopting modern cooking fuel sources. Therefore, policies to increase and expand these factors will encourage households in Bauchi State to adopt modern and clean sources of cooking fuels. On the other hand, variables like age of the household head, gender of the household head and home appliances are negatively and significantly related to the odds of adopting modern cooking fuel sources. Therefore, policies to discourage these factors will encourage the households in Bauchi State to reduce the use of traditional biomass fuels for cooking purposes. Lastly, as a limitation, this study is only a preliminary analysis based on a sample size of 30 households, a number which is insufficient to represent the true picture of households of Bauchi State, Nigeria. Therefore there is a need for another study on the same issues with a sample size that will represent the population of households in Bauchi State, Nigeria.

Acknowledgements

The authors are grateful to the two anonymous reviewers for improving the quality of the paper.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

[1] NBS. Annual abstract: federal republic of Nigeria. 2010 [Retrieved 7th August, 2014]. Available from: http://www.nigerianstat.gov.ng
[2] Akpan M, Akpan M, Wakili A, et al. Fuel Wood Consumption Pattern in Bauchi State: A Guide for Energy Planners in Nigeria. ASSET: An Int J (Series A}. 2010;7(1):1–11.
[3] AY N, Ibrahim AQ, Hamid BM., et al. Analysis of firewood supply in Bauchi State. Prog Renew Energies.2011;1:1–7.
[4] Wakili A, Abdullahi MB, Gani AM, et al. Combustion Rate of Ten Wood Fuel Tree Species in Bauchi State. IJABR. 2012;4(1&2):171–177.
[5] The Tide. Gruelling Bauchi desertification: Any succour in sight? 2010 [Retrieved 7th October, 2014] Available from: http://www.thetidenewsonline.com/2010/10/11/gruelling-bauchi-desertification-any-succour-in-sight/
[6] Lee LY. Household energy mix in Uganda. Energy Econ. 2013;39:252–261.
[7] Nlom JH, Karimov AA. Modeling fuel choice among households in northern Cameroon. WIDER Working Paper Series, 2014/038.45; 2014.
[8] Oyekale A, Dare A, Olugbire O. Assessment of rural households' cooking energy choice during kerosene subsidy in Nigeria: A case study of Oluyole local government area of Oyo State, Nigeria. Afr J Agric Res. 2012;7:5405–5411.
[9] Mekonnen A, Köhlin G. Determinants of household fuel choice in major cities in Ethiopia. Working Papers in Economics No 399; 2008.
[10] Onoja AO. Econometric analysis of factors influencing fuel wood demand in rural and Peri-urban farm households of Kogi State. J Sustain Dev. 2012;8(1):115–127.
[11] Song N, Arguilar FX, Shifley SR, et al. Factors affecting wood energy consumption by U.S. households. Energy Econ. 2012;34:389–397.
[12] Couture S, Garcia S, Reynaud A. Household energy choices and fuelwood consumption: an econometric approach using French data. Energy Econ. 2012;34:1972–1981.
[13] Jingchao Z, Kotani K. The determinants of household energy demand in rural Beijing: can environmentally friendly technologies be effective? Energy Econ. 2011;34:381–388.
[14] Nnaji C, Ukwueze E, Chukwu J. Determinants of household energy choices for cooking in rural areas: evidence from Enugu state, Nigeria. Cont J Soc Sci. 2012;5(2):1–11.
[15] Ganchimeg G, Havrland B. Economic analysis of household energy consumption: the case of herders in Mongolia. Agri Trop Et Subtrop. 2011;44:197–203.
[16] Heltberg R. Factors determining household fuel choice in Guatemala. Environ Dev Econ. 2005;10:337–361.
[17] Jumbe BLC, Angelsen A. Modeling choice of fuelwood source among rural households in Malawi : A multinomial probit analysis. Energy Econ. 2010;33:732–738.
[18] Laureti T, Secondi L. Determinants of households' space heating type and expenditures in Italy. Int J Environ Res. 2012;6:1025–1038.
[19] Fan S, Hyndman R. The price elasticity of electricity demand in South Australia. Working Paper Series, 16/10 for Department of Econometrics and Business Statistics. Australia: Monarsh University; 2010.
[20] Souza LCL, Postigo CP, Oliveira AP, et al. 2009. Urban heat islands and electrical energy consumption. 113–121.
[21] Helden JV, Leeflang SH, Sterken E. Estimation of the demand for electricity. Appl Econ. 2001;19:69–82.
[22] Petersen SL. Micro econometric modelling of household energy use: Testing for dependence between demand for electricity and natural gas. Energy J. 2002;23(4):57–84.
[23] Westley GD. Non traditional partial adjustment models and their use in estimating the residential demand for electricity in Costa Rica. Land Econ. 1989;65(3):254–271.
[24] Terza JV. Determinants of household electricity demand: A two Stage probit approach. Southern Econ J. 2001;52:1131–1139.
[25] Aina OI. Domestic Energy Situation in Nigeria: Technological Implications and Policy Alternatives. ATPS Working Paper No. 25; 2001.
[26] Bradford M, Joachim S. Analysis of existing data: determinants for the adoption of energy-efficient household appliances in Germany. ZEW Econ Stud. 2012;44:39–67.

[27] Michael KB, Gallini NT, Miller EJ, et al. Disaggregated analysis of the demand for gasoline. Canad J Econ. 2001;90:253–275.
[28] Niemeyer S. Consumer voices: adoption of residential energy-efficient practices. Int J Consum Stud. 2010;34:140–145.
[29] Ritchie J, Mcdougal G, Claxto D. Complexities of household energy consumption and conservation. J Consum Res. 1981;8:233–242.
[30] Mensah T, Adu G. An empirical analysis of household energy choice in Ghana. Uppsala Working Paper Series No 6; 2013.
[31] Özcan KM, Gülay E, Üçdoğruk S. Economic and demographic determinants of household energy use in Turkey. Energy Policy. 2013;60(2013):550–557.
[32] Osiolo HH. Enhancing household fuel choice and substitution in Kenya. Nairobi: Kenya Institute for Public Policy Research and Analysis; 2010.
[33] Eakins J. An analysis of the determinants of household energy expenditures: empirical evidence from the Irish household budget survey [PhD thesis]. UK: University of Surrey; 2013.
[34] Suliman MK. Factors affecting the choice of households' primary cooking fuel in Sudan. Research report presented to the Economic Research Forum, Cairo, Egypt;2010.
[35] Risseeuw N. Household energy in Mozambique: A study on the socioeconomic and cultural determinants of stove and fuel transitions [Unpublished Master's thesis]. Amsterdam: Vrieje University; 2012.
[36] Heltberg R.. Household fuel and energy use in developing countries: A multi-country study. ESMAP Technical Paper No. 42, Washington: World Bank; 2003.
[37] Danlami AH, Islam R, Applanaidu SD. An analysis of the determinants of household energy choice: A search for conceptual framework. Int J Energy Econ Policy. 2015; 5(1):197–205
[38] Gujarati DN. Basic Econometrics. 4 ed. New Delhi, India: Tata McGraw hill Publishing Company, Limited; 2004.
[39] Wang Z, Zhang B, Yin J, et al. Determinants and policy implication of household electricity saving behaviour: Evidence from Beijing China. Energy Policy. 2011;39:3550–3557.
[40] Pundo MO, Fraser GC. Multinomial logit analysis of household cooking fuel choice in rural Kenya: The case of Kisumu district. Agrekon. 2006;4524–37.
[41] Link CF, Axinn WG, Ghimire DJ. Household energy consumption: community context and the fuel wood transition. Soc Sci Res. 2011;41(2012):598–611.
[42] NBS. Annual abstract: federal republic of Nigeria. 2012 [Retrieved February, 2016]. Available from: http://www.nigerianstat.gov.ng
[43] Santos JR. Cronbach's Alpha: A Tool for Assessing the Reliability of Scales. J Ext. 1999;32(2).
[44] Gliem JA, Gliem RR. Calculating, Interpreting and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. A paper presen[TQ10]ted at Midwest Research Conference, The Ohio state university, Columbus; 2003.
[45] Roscoe JT. 1975. Fundamental research statistics for the behavioural sciences. 2nd ed.. New York: Holt, Rinehart and Winston.
[46] Sekaran U. Research methods for business: A skill-building approach. 4th ed. John Wiley & Sons, Inc;.2003
[47] Bartlett JE, Kotrlik JW, Higgins C. Organizational Research: Determining Appropriate Sample Size in Survey Research. Inf Tech Learn Perform J. 2001; 19(1): 43–50.
[48] Eakins J. An econometric analyses of Irish residential transport expenditures. Proceedings of the ITRN2011, University College, Cork 2011.