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FACTORS INFLUENCING CHARCOAL CONSUMPTION AS COOKING ENERGY AMONG HOUSEHOLDS IN GBOKO URBAN AREA OF BENUE STATE, NIGERIA: PERCEIVED IMPLICATIONS ON FOREST ESTATES

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ABSTRACT

In developing countries, households in both rural and urban areas have relied too much on charcoal as a source of energy for cooking. This study analyzed factors influencing use of charcoal as domestic energy source by households in Gboko urban area of Benue State, Nigeria and the perceived implications on forest estates. Multi-stage stage sampling technique was used to select a total of one hundred and eighty (180) respondents for the study. The study's data was sourced from primary source through administration of structured questionnaire and household interviews. Descriptive statistics, four point likertscale and multiple regression model were employed to analyse the acquired data.The study found that affordability (cheapness) (87.0%), neatness (62.0%) and easy availability (48.0%)were the primary factors in choosing charcoal as household cooking energy in the study area. Household size and cost of liquefied petroleum gas (LPG) positively influenced the consumption of charcoal by households while educational status and monthly income negatively influenced charcoal consumption in the study area. The perceived effects of charcoal consumption on forest estates includes; deforestation (3.0), reduced natural regenerative capacity of forests (2.72), wind and soil erosion (2.60) and loss of biodiversity (2.59).The study concluded that household charcoal consumption has negative effects on the environment and human health. It is therefore crucial for the government and energy stakeholders to develop strategies to help households rely less heavily on hard fuels like charcoal and firewood.

Keywords: Charcoal, households, energy source, implications, forest estates

Introduction

Charcoal made from wood has been in use as energy source since ancient times and is still widely used nowadays in many countries (African Forestry and Wildlife Commission, 2020). Millions of people in sub-Saharan Africa who have few other options, especially those who live in urban and peri-urban areas, rely on charcoal as a locally accessible fuel for cooking and heating because it is relatively clean compared to burning wood or agricultural waste (AFWC, 2020). Fuelwood remains a dominant energy source in the developing world in both rural and urban areas as over 2 billion people in developing countries are still mainly dependent on it for cooking and heating (Johnson *et al.*, 2010). More than 2.4 billion people and small businesses depend on fuelwood and charcoal as significant energy sources worldwide (FAO, 2014). According to a national charcoal survey conducted in Uganda in 2015, only a very tiny portion of urban families completely rely on gas or electricity as majority of the urban families use charcoal and fuelwood for cooking (National Charcoal Survey for Uganda 2015). Similar conditions and trends in charcoal production and consumption have been seen in studies undertaken in Ghana (UNDP, 2015), Kenya (MOE, 2019), Malawi by the Ministry of Natural Resources, Energy and Mining (MNREM, 2017), and Tanzania (World Bank, 2009).

For instance, in Malawi, 11% of all families nationwide and 54% of urban households in 2015 used charcoal for cooking. Charcoal would continue to be a significant source of energy in SSA by 2040 due to rising demand for cookingenergy in urban areas, according to a special report on Africa's energy forecast by the International Energy Agency (IEA, 2019). Since many people are switching from fuelwood to charcoal for residential cooking and heating, the rise is probably related to population expansion and the early stages of urbanization. The increase is probably related to the early stages of urbanisation and population growth, as many people switch from using fuelwood for home heating and cooking to charcoal. It may also have a direct connection to the reality that theproduction and supply of charcoal donot necessitate the creation of expensive and durable infrastructure, like that for electricity or natural gas, which results in lower economic and social barriers.

According to FAO estimates, 34.2 million tonnes (or roughly 64 percent) of the total 53.2 million tonnes of wood charcoal produced worldwide in 2018 were generated in Africa. According to FAOSTAT data, nearly 90% of the wood harvested from African forests and woodlands is utilised as fuel, of which about 29% is turned into charcoal (FAO, 2019). Due to a consistent rise in consumer demand, Africa produced nearly twice as much wood charcoal as the rest of the world combined between 1998 and 2018, accounting for roughly two-thirds of worldwide output. Charcoal offers clear advantages over burning wood directly as fuel. Charcoal fires can burn hotter and longer while producing less smoke because moisture and volatile substances from wood are removed. Additionally, charcoal is more affordable and easier to transport than wood, especially over long distances. As a result of these comparative advantages as well as its accessibility, affordability, and dependability in local markets, charcoal is a widely used cooking fuel in many nations, especially in regions without consistent access to modern energy services or during humanitarian crises. In contrast to electricity, cooking gas or other contemporary energy sources, charcoal may not be the best fuel for cooking and heating from an energy perspective.

Large-scale charcoal production, which is primarily centred in sub-Saharan Africa, has come under increased scrutiny as a result of the possible threat of deforestation, land degradation, and climate change implications. It is said to be the most damaging stage of this traditional energy supply chain for the environment (Zulu and Richardson, 2013). According to FAO (2017), the primary drivers of forest degradation especially in SSA is the unsustainable charcoal production and fuelwood gathering which is encouraged by unrestricted access to forests. An earlier investigation by Butz(2013) into the relationships between the production of charcoal with deforestation and forest degradation in Tanzania revealed that charcoal production caused the catchment region to the west and north of Dar es Salaam to lose 20% of its closed woodland and 51% of its open woodland.While the production of charcoal provides revenue to support the livelihoods of many rural residents, it also contributes to environmental degradation, decreasing wood supply, and deforestation. Correctional measures in the past that prohibited the production of charcoal did little to help with these issues, but instead encouraged illegality in its production, transportation, and commercialization (AFWC, 2020). According to the International Energy Agency (IEA, 2019), the unsustainable collection of fuelwood, which is mostly motivated by ineffective charcoal production for cities, has a major impact on the environment and can occasionally result in deforestation. Although research by Kissinger (2012) and Zulu (2013) have shown links between them, systematic and sound data are currently insufficient to conclusively link concentrated charcoal production to feed urban markets to forest degradation and/or deforestation. In South Saharan Africa, natural forests or woods are widely used to harvest wood for charcoal production. It may also be a result of clearing land for farming.Depending on the existence of relevant legislation, charcoal producers who are primarily part-time rural workers may require a license or permit in order to harvest wood for charcoal manufacturing. The complexity of this informal sector has meant that most of these regulatory initiatives, such as quotas, licenses, permits, taxes, and in some cases sustainability certification, have had inconsistent results thus far (FAO, 2017).

In Nigeria charcoal is mainly produced in the rural areas especially areas close to forests, and transported to the urban centres after production. The production is at a sub-industrial level and it has an adverse effect on the environment locally and globally (Federal Ministry of Environment, 2006; Rotowa *et al*., 2019). FAO indicated that from 1990 to 2005, 35.7% of Nigeria's forest cover was lost and approximately 12% of the country's land is presently forested while 350,000 hectares of land is being lost yearly to desertification (FAO, 2004). The rate of fuel wood and charcoal consumption in Nigeria ranks highest in Africa and this resulted in land degradation, loss of biodiversity and accelerated climate change(Olori, 2009). Charcoal production in Nigeria causes a variety of issues, including environmental pollution from smoke, deforestation due to tree harvest, erosion that exposes the soil to direct sunlight, a decrease in soil fertility, and health issues for those living nearby the production site (Ajadi*et al*., 2012).

Charcoal production is very prominent in Benue, Kogi and Niger States of Nigeria where there are guinea belts that support its production(Rotowa*et al*., 2018). The ecosystem has been negatively impacted by the overuse of farmlands, the destruction of forests, and the removal of fruit-producing trees for the production of charcoal. Charcoal production has been regarded as a good industry for revenue generation among rural poor in an effort to raise living standards, spurred by free access to forest resources, up until such forest area is being destroyed. The useof wood presently surpasses the regrowth of forests andreforestation efforts have been very poor(Rotowa*et al*., 2018).

In Gboko Local Government Area of Benue State, charcoal accounts for major part of the energy sources for domestic needs. More people depend on the use of charcoal as source of energy and more trees are felled for such usage. The rate of trees exploitation is enormous as the area is almost stripped bare of its vegetation coverage. The exploitation of fuel wood has progressed from the simple act of gathering dead wood to the everyday large-scale, intentional, and wanton cutting of trees using power saws.However, a comprehensive understanding of the economic issues that support charcoal consumption is lacking in the study area. To this end, this study analyzed charcoal consumption as cooking energy by households in Gboko urban area of Benue state and its effects on forest estates. Specifically, the seeks to described the socio-economic characteristics of household heads in the study area, identify the different energy combinations used by households in the study area, estimate the quantity of charcoal used by households per month in the study area, identify the reasons for charcoal preference over other energy sources in the study area, examine the perceived impact of charcoal production and consumption on forest estates and determine the factors influencing charcoal consumption by households in the study area.

Materials and Methods

The study was conducted in Gboko Local Government Area of Benue State. Gboko Local Government is located between latitudes 6^0 3'and 8^0 1' North of the Equator and longitudes $8^0$and 10^0 East of the Greenwich Meridian. The Local Government is bounded by Tarka and Guma local government's Areas to the north, Ushongo Local Government to the south, Buruku Local Government to the East, and Konshisha Local Government to the South- West while GwerLocal Government lies in the West. The local government covers a land mass of 2264 km^2 with a population of 361,325 people based on the 2006 census (National Population Commission, NPC, 2006).The projected population by 2022 stands at 521,700 people going by a population growth rate of 2.3% per annum making Gboko one of the most populous Local Government Areas in Benue State.

The Local Government Area has a tropical climate marked by two distinct seasons (the wet or rainy season and the dry season). The rainy season lasts from April to October with an August break. The annual rainfall is in the range of 1500 mm to 1800 mm. The dry season begins in November and ends in March with a dust laden spell, the Harmattan wind that blows from across the Sahara. The temperature fluctuates between 23^oC and 35^oC. Gboko Local Government Area has six districts and seventeen wards. The districts are; Ipav, Mbayion, Yandev, Township, Mbatyav and Mbateriev while the wards include; Gboko North/West, Gboko South, Gboko East, Gboko Central, Igyorov, Mbakpegh, Mbadim, Mbaanku, Mbaavarakaa, Mbakwen, Mbadam, Mbatyu, Ukpekpe, Mbatsegh, Mbatan, Mbaiwar and UtabarMbateriev. However, this study focused on the urban wards that constitute Gboko metropolis.

Sampling Procedure and Sample Size

A multi-stage sampling technique was used for this study. The first stage involved the stratification of Gboko metropolis in to five (5) wards. They include; Gboko-West, Gboko-North, Gboko-South, Gboko-East and Gboko central. These areas were selected purposively because they are urban and possess the characteristics of the targeted population of the study. Secondly, two communities were randomly selected from each of the wards giving a total of ten (10) communities for the study.

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Finally, purposive sampling technique was used to select eighteen (18) household heads that use charcoal as their primary or secondary household fuel in each of the community giving a total of one hundred and eighty (180) respondents for the study. The primary data for this study was obtained through structured questionnaire and household interviews. Questionnaire was administered to either household heads or their spouses because they are responsible for cooking energy decisions.

Data Analysis

Data collected were analyzed using descriptive statistics, four point likertscale and multiple regression analysis.

Four point Likert scale

Respondents' perception of the effects of trees extraction for charcoal production on the forest estates was determined by perception score using Four point Likert scale. The Likert scale is a measure of attitudes, preferences and subjective reactions by eliciting a response along the lines of strength of agreement with the scale items. Here perception score was calculated by plotting seven statements regarding the effects of trees extraction on the environment against a four-point scale: 'strongly agree' 'agree', 'strongly disagree' and 'disagree', weighted as 4, 3, 2 and 1, respectively.

The score of seven statements was summed to calculate the perception score of every household head. Based on the 4- point scale, a mid-point of 2.50 was established thus: 4+3+2+1 ÷ 4. Decision rule was therefore made that any statements regarding the effects of trees removal for charcoal production on the forest estates with a mean score greater than or equal to 2.50 is perceived as having a strong negative effect on the available forest estates in the study area while any statement with a mean score less than 2.50 is perceived as not having a strong negative effect on the forest estates in the study area.

Multiple Regression Model

The linear multiple regression analysis was used in determining the factors influencing charcoal consumption in the study area. The explicit form of the model is presented as: $Y = a0 + ß_1X_1 + ß_2X_2 + ...+ ß_9X_9 + e$

Where;

Y = Quantity of charcoal used per month (Kg)
X_1 = Sex (male =1 and female = 0)
X_2 = Age (years)
X_3 = Marital status (Dummy, where 1=married and 0 = otherwise)
X_4 = Household size (measured by number of people in a household)
X_5 = Education level (measured by years of formal schooling)
X_6 = Monthly income (₦)
X_7 = Cost of Kerosene (₦ /Kg)
X_8 = Cost of liquefied gas (₦ /Kg)
X_9 = Cost of Electricity (₦ /Kwh)
a0, $ß_1$ - $ß_9$ were parameters estimated
e = Error term

Results and Discussion

Result from Table 1 shows that the respondents had a mean age of 43 years. Age is an important factor in household energy preference because adults are more likely to engage in energy issues than the dependent age group. There is a particular age bracket that when reached, household heads are more conscious about the disastrous effects associated with incessant consumption of fuel wood. Hence, he/she will use his/her life time savings for consumption of the modern energy sources. The result also shows that majority of the household heads were males constituting 74% of the respondents. This male dominance is in line with the religious and cultural ethics in the study area where males function as household's head except in some areas where females function as household's head either as widows or divorcees. The result in Table 1 also shows that 87% of the respondents are married.

According to Tchereni (2013), Karakara and Osabuohien (2018), marital status has a positive effect on gravitating towards the adoption of clean fuels. It is usual that the demand for cooking energy among married people is higher as a result of their large household sizes. The result further revealed that 77% and 17% of the respondents had tertiary and secondary education respectively. This was expected as the study location is an urban area with high literacy level. It is established that the higher the education level, the more the individual will gravitate or resort to using clean energy sources, such as electricity. On the other hand, individuals with a lower education level will gravitate or resort to using dirty energy sources, such as firewood and charcoal.

The result also showed an average household size of 4 persons in the study area. As household size increases, there is a probability of the household switching or combining energy source to carter for the increasing number. The results in Table 1 further showed that 54.0% of the respondents were civil servants 30% were businessmen\women. The high percentage of civil servants was expected due to the fact that the area is an urban and administrative center for many government institutions. Also, the high percentage of businessmen was expected because the area is a business area with a high number of shops and a major market where a lot of commerce takes place. The result also showed a mean monthly income of N85, 233 by household heads in the study area. The higher the income of the household head, the greater the flexibility of shift to the desired household fuel.

Table 1: Distribution of Respondents Based on their Socio-economic Characteristics (n=180)

Variable	Frequency	Percentage	Mean
Age (years)			
21- 30	11	6.0	
31- 40	59	32.0	
41 – 50	74	43.0	
50 above	36	19.0	43.0
Sex			
Male	133	74.0	
Female	47	26.0	
Marital status			
Single	171	87.0	
Married	9	13.0	
Educational level			
Primary	11	6.0	
Secondary	31	17.0	
Tertiary	138	77.0	

Household size (number)			
1-3	66	37.0	
4-6	99	55.0	
>6	15	8.0	4
Major occupation			
Civil servant	97	54.0	
Business/trading	54	30.0	
Artisans	15	8.0	
Farming	5	3.0	
Others	9	5.0	
Monthly income (Naira)			
10,000- 50,000	56	31.0	
51,000-100,000	63	35.0	
101,000-150,000	41	23.0	
151,000-200,000	15	8.0	
>200,000	5	3.0	85, 233

Reasons for Charcoal Preference

The various reasons for household's preference of charcoal over other energy types are shown in Table 2. It was found that 87.0% of respondents preferred charcoal because it is cheap, 62.0% said they prefer charcoal to other energy sources because it is neat while 48.0% of the households use charcoal because it is easily available.

A study conducted by Rotowa*et al.* (2019) and Anang *et al.* (2011) also reported that households prefer charcoal because it is predominantly produced and sold locally and unlike other means of energy such as cooking gas, kerosene and electricity, charcoal is affordable and readily available and does not require any organized distribution network before the end user can access it. More so, charcoal stoves are produced locally and very affordable compared to electric stove, cooking gas cylinder and kerosene stoves which are costlier. Investigations revealed that charcoal consumption is higher among low income individuals and families with charcoal and fuel wood accounting for three-quarters of their total household energy expenditure.

Table 2: Distribution of Respondents Based on Preference for charcoal

Reasons for charcoal preference	*Frequency	Percentage
Cheap	156	87.0
Neat	111	62.0
Easily available	86	48.0

***Multiple responses**

Households Level of Charcoal Consumption

Result in Table 3 below indicates that 49% of the households consumed 101-150kg of charcoal per month, 37% consumed about 50-

1000kg per month, 11% consumes between 151-200kg per month while 6% consumes above 200kg of charcoal per month. The average monthly consumption of charcoal by households in the study area is 115.3 kg. Because it is less harmful and smoky than cooking with wood while being more cost-effective than petroleum products, charcoal is frequently utilised as a fuel in urban and semi-urban regions (ZidagoandWang, 2016).

Table 3: Distribution of Respondents Based on Quantity of charcoal consumed per month

Quantity consumed/month (kg)	**Frequency**	**Percentage**	**Mean**
50-100	67	37.0	
101-150	88	49.0	
151-200	19	11.0	
>200	6	3.0	**115.3**

Average Cost price of Charcoal and Alternative Energy Types in the Study Area

The prices of cooking energy were determined for the various energy types in the study area. The essence was to know the cost price of alternative energy sources which is a strong determining factor in the choice of energy by households. The result in Table 4 indicates that the mean price of charcoal in the study area is ₦2954/50 kg bag, firewood is ₦200 per small bundle, kerosene ₦750/litre, electricity ₦74.04/kwh and gas ₦800/kg.

None of the energy types is subsidized, and there is no incentive for consuming any of the energy types. A cursory look at the various energy prices reveals that firewood and charcoal have the lowest prices as compared to the other cleaner fuels like kerosene, LPG and electricity. This may justify the overdependence on charcoal and firewood as household's energy sources in the study area.

Table 4: Average cost price of Charcoal and Alternative Fuels in the Study Area

Energy type	**Average unit price (₦)**
Charcoal	2954 (50kg)
Firewood	200 (per small bundle)
Kerosene	750 (Litre)
Liquefied gas	800 (kg)
Electricity	74.04 (1Kwh)

Energy Combination with Charcoal by Households

Charcoal is either consumed by householders in combination with other fuels or on its own. The result in Table 5 shows that of the 180 households surveyed, only18% of households use only charcoal as cooking energy as majority of the households (51%) use charcoal and firewood, 25% use charcoal and cooking gas (25%), while a few (5%) use charcoal and kerosene. It can be seen from the result that households rarely depend on a single fuel but rather utilize a combination of different fuels. This also reveals how traditional fuels like charcoal and firewood are predominantly used either exclusively or in combination with those modern fuels.

The major justification why households use multiple fuels is partly related to the fact that some fuels are only convenient for undertaking specific cooking activities. Also, some fuels are not always available and seasonal changes are likely to induce change of fuel (Vihi *et* al., 2018).Most homes use a range of fuels, potentially and collectively included at all levels of the energy ladder; fuel substitution and transition do not apply, especially in developing nations. The non-usage of electricity as a primary source of energy was expected because of the high electricity tariff and inconsistent power supply.

Table 5: Distribution of Respondents based on Energy Combination with charcoal

Quantity consumed/month (kg)	Frequency	Percentage
Charcoal only	35	19.0
Charcoal and firewood	89	49.0
Charcoal and kerosene	11	6.0
Charcoal and gas	45	25.0
Charcoal and electricity	-	

Perceived Implications of Charcoal Consumption on Forest Estates

The respondents' perception of the effects of continuous charcoal consumption is presented in Table 6. From the result, the respondents strongly agreed with the following statements as true; 'felling trees for charcoal causes deforestation (3.0), unsustainable cutting down of trees affects the natural regenerative capacity of forests (2.72), cutting down trees leads to wind and soil erosion (2.60), trees harvesting leads to loss of biodiversity (2.59). Theabove items all had mean scores greater thanthe criterion mean score of 2.50 and aretherefore considered as perceived effects of tree harvesting for charcoal production.It can be observed from this result that the greater number of the respondents agreed to the fact that use of wood for charcoal production directly escalates the problem of deforestation.

This is true because the production of charcoal involves the cutting of trees over a large forest area leading to depletion of trees population and alteration of the forest structure. The continuous production of charcoal leads to continuous deforestation which in-turn is a threat to sustainable forest conservation. Thus the uses of forest trees for charcoal production still represent a threat to the future of the forest especially in areas with high demand. According to Rotowa*et al*. (2019), charcoal production is one of the main human induced activities that give rise to deforestation in Nigeria. It is also true that when trees are cut, the forests no longer support the same wildlife as effectively as it did before and this may place its inhabitants at risk. In a study done by Diaz (2006), it was discovered that logging led to the destruction of vital microbial ecosystems as well as the natural habitats of wild animals, vegetation species, fruit trees, and trees of medicinal relevance.

The production of charcoal has led to massive forest depletion in Congo where it is reported to threaten the survival of mountain gorillas (Rotowa*et al*., 2019). Similar threat was also reported in Zambia. The natural regenerative capacity of forests is also threatened by

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continuous and unregulated exploitation. According to Vihi*et al*. (2020), the community people believe that the more the trees they are able to harvest from the forests, the more it translate to money for them. The danger which this belief is posing is that the sustainability of the resource base is being threatened on a daily basis because the harvesting rate is greater than the rate of natural regeneration of the resource base. Cutting down trees for charcoal production also leaves the lands bare leading to massive soil erosion owing to the fact that the soil would not have tree roots to hold it together. Trees act as very good safeguards against strong wind and so, cutting down of trees for fuel predisposes the land to very strong windstorms undeterred by lack of windbreaks leading to losses in lives and properties. The responses were reflective of the ability of the respondents to identify trees as important and effective in assuring them their economic and environmental needs. This equally brings to the fore the capacity of the respondents to attach a high premium to trees in their daily livelihoods.

Table 6: Perceived Effects of Charcoal Consumption on Forest Estates

Perceived effects on forest estates	SA(4)	A(3)	SD(2)	D(1)	Sum	Mean
Felling trees for charcoal production causes deforestation	97	111	21	11	724	3.01*
Unsustainable removal of trees for charcoal affects the natural regenerative capacity of forests	66	83	45	46	654	2.72*
Cutting down trees for charcoal leads to wind and soil erosion	61	76	51	52	626	2.60*
Trees harvesting leads to loss of biodiversity	57	79	54	50	623	2.59*
Trees harvesting for charcoal leads to desertification	47	51	69	73	552	2.30
Removal of trees for charcoal causes extinction of some specific tree specie	37	49	78	76	527	2.19

Factors Influencing Charcoal Consumption as Cooking Energy by Households

The result of the multiple regression analysis is presented in Table 7. The linear function gave the best fit and hence, was selected as the lead equation based on the number of significant variables, plausible magnitude of the regression coefficients, magnitude of the coefficient of determination (R^2) and correctness of signs of the coefficients. Other functional forms tried were the double-logarithm, exponential and semi-logarithm functions. The coefficient of multiple determination of 0.4480 indicates that about 44.80% of the variation in charcoal consumption in the study area has been captured by the model. The implication of this outcome is that 44.80% of charcoal consumption is caused by the explanatory variables. The result shows that four of the nine explanatory variables used in the model significantly affected the consumption of charcoal by households. These variables are; household size (X_4), educational level (X_5), monthly income (X_7) and cost of cooking gas (X_8).

The result of the regression indicates that the estimated coefficient of household size ($\mathbf{X_4}$) is significant at 1% probability level with a positive (0.685) coefficient. This means that for every unit increase in household size in the study area charcoal consumption will increase by 6.85 percent. As expected, given the high-energy requirement to prepare meals for a large family coupled with low level of household's income, an increase in its members can expose the household to a certain degree of poverty. Subsequently, the household could find it difficult to meet with its energy consumption demand and inevitably resort to charcoal consumption due to its affordability and easy accessibility. This result tally with the findings of earlier previous studies like; Onoja (2012); Song *et al*. (2012) and Lee (2013); but contradicts the findings of Jingchao and Kotani (2011).

Educational status ($\mathbf{X_5}$) of respondents using charcoal had a negative coefficient (-0.0929) and was statistically significant at 10% level of probability. This means as the educational level of respondents increase, their probability to use charcoal as their energy source decreases. This means that the probability that the respondents will use cleaner energies (gas and electricity) increases with increase in their level of education. In other words, with everything else held constant, the respondents having more education are more likely to switch over to those charcoal alternatives like gas and electricity. This conforms to the theoretical expectation that as household heads gain more education, the demand for charcoal alternatives will increase. This is because education improves knowledge of fuel attributes, taste, and preference for better fuels.

Coefficient of monthly income ($\mathbf{X_7}$) was significant at 10% probability levels with a negative (-0.1599) coefficient, showing that for every 1% increase in income of household heads, charcoal consumption decreases by 1.59%. Increase in income increases the purchasing power of people; hence, households may increase the consumption of other alternative sources of domestic fuel such as kerosene and gas and electricity thereby reducing the consumption of charcoal. Usually when there is an increase in income, solid fuels (charcoal and firewood) usually give way to a liquid fuel (kerosene), which in turn is displaced by LPG and electricity, which are the most desirable energy forms in high-income households. Households tend to move up the energy ladder in terms of quality, convenience to use and cost from biomass to kerosene and then to LPG or electricity with increasing disposable income and changes in lifestyles. This agrees with the study by Ogwuche and Asobo (2013) who reported that the higher the income of the head of household, the greater the flexibility of shift to the desired household fuel. Danlami*et al.* (2018) found that increase in income and living in urban areas reduce the probability of using wood fuels as the main source of cooking fuel in developing areas.

Coefficient of cost of Gas ($\mathbf{X_8}$) was significant at 1% probability levels with a positive (0.084) coefficient. This implies that for every unit increase in price of gas the quantity demanded of charcoal in the study area rises by 8.4%. This is in line with theoretical expectations that the higher the price of the product (gas in this case), the higher the consumption of its substitute or alternative product (charcoal). Thus an increase in the cost of cooking gas would lead to an increase in charcoal use as those of low to middle income strata will source alternative energy sources that are relatively cheaper and also readily accessible.

Table 7.Determinants of Household Charcoal Consumption

Variable	Coef	Std error	T-Value	P-Value
Constant	5.57	4.02	1.38	0.168
Gender (X_1)	-0.0233	0.0338	-0.69	0.492
Age (X_2)	0.139	0.251	0.55	0.580
Marital status (X_3)	0.0147	0.0440	0.33	0.739
Household size (X_4)	0.685	0.100	6.82	0.000***
Educational status (X_5)	-0.0929	0.0481	-1.93	0.055*
Monthly income (X_6)	-0.1599	0.0812	-1.97	0.051*
Cost of kerosene (X_7)	-0.413	0.461	-0.90	0.371
Cost of gas (X_8)	0.084	0.009	9.34	.000***
Cost of electricity (X_9)	0.019	0.427	0.05	0.964
Number of obs =	180			
R-squared =	0.4480			
Adj R-squared =	0.4154			
Pob> F = 0.0000				

*** and * = Significant at 1% and 10%

Conclusion

From the findings of this study, it can be concluded that majority of the respondents were married, within their active ages and had at least one form of education with tertiary and secondary education having the highest share. Majority of them were civil servants with moderate level of income and large family sizes. The major households energy for cooking in the study area is charcoal and firewood which is often times combined with kerosene, liquefied petroleum gas and electricity. Fuels are not totally switched in the study area, but a multiple fuel stacking is adopted.

The average price of charcoal in the study area stood at ₦2954/ 50 kg bag which is considered more affordable and easily available. Affordability (cheap), neatness, easy availability were the major reasons for choice of charcoal as household cooking energy in the study area. Deforestation, reduced trees population, reduced natural regenerative capacity of forests, wind/soil erosion and loss of biodiversity werethe perceived effects of tree harvesting for charcoal production in the study area. Marital status, household size and cost of gas positively influenced households consumption of charcoal while educational status and monthly income had negative relationship with charcoal consumption in the study area.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Government should formulate integrated policies, strategic initiatives and programs at national or local levels aimed at addressing the charcoal issues in a more systematic way.
2. The government should foster the growth of the infrastructure required for the production of biofuels for domestic consumption. Instead of the current ineffective usage of unprocessed biomass, this will ensure the economic utilization of the abundant biomass resources in the area.
3. Programmes for educating locals about alternative energy sources and the related technologies should be made accessible and reasonably priced for them. Also, tree planting campaign should be embarked upon by both residents and relevant authorities to replenish the depleted forest resources and for its sustainability.

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