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Original Article

Trees species for fuelwood consumption in northern guinea savannah ecoregion of Nigeria: Empirical study of two selected local government areas of Katsina state

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ABSTRACT

Evaluation of tree species for fuelwood consumption in two selected Local Government areas of Katsina State Northern Guinea Savannah Ecoregion of Nigeria was studied. Sixty questionnaires were randomly administered in each of the two selected local government areas to make a total of 120 questionnaires. One hundred were retrieved. The result revealed that *Isoberlinia doka* was the most preferred (24%) tree species for fuel consumption because of its high five retaining capacity, low smoke, and low moisture holding capacity while *Cassia* species is the least (3%). The major (70%) source of fuel wood supply to the market was from the forest. Faskari local government consumed more fuelwood/head/year (55.67 t/person/year) while Sabuwa Local Government had (38.64 t/person/year). Fuelwood was the major (33%) energy sources while gas (2%) was the least. Socioeconomic characteristics of the respondents were also examined. The percentage of male was (68%) while that of their female counterpart was (32%). Majority (50%) are married with a majority (35%) having 7–8 house hold size. About 37% of the respondents had primary education while 26% had no formal education and majority (42%) were farmers. However, it is recommended that there is a need for artificial regeneration of tree species exploited in the form of woodlots, community forest plantation for continuous supply of wood on a sustainable bases, and also other alternative sources of energy such as kerosene stove, gas cooker, and solar should be encouraged and subsidized to the general populace to reduce the pressure on forest estate.

Keywords: Consumption, ecoregion, fuelwood, Katsina northern guinea savannah, tree species

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INTRODUCTION

Wood is an organic carbon based material that reacts with oxygen in combustion and natural metabolic processes to release heat.[1] Wood biomass may be considered as chemical energy storage from the point of view of utilization because, the energy biomass of oxygen system is obtained from solar radiation, which is collected and stored by trees during the process of photosynthesis.[2] Fuelwood can be said to be a source of energy derived by burning wood material such as logs and twigs and is common among the rural dwellers. It is a traditional source of energy, which has remained the major source of fuel for over half of the world's population.[3,4] Fuelwood is consumed in diverse ways and at different levels and the life of the majority of the local dwellers in these local government areas depend either directly or indirectly on the fuelwood. However, meeting rural household, wood fuel needs in the country have become a herculean task due to the enormous quantity of wood required. Daily consumption of firewood by the rural communities in Nigeria is estimated at 27.5 million kg/day.[5] This observation was also buttressed by another data published by the Solar Cooking Archive (2011) which put the estimate of Nigeria's fuelwood consumption as a percentage of energy at about 87%. Therefore, majority of Nigerian rural people have been using and will continue to use the dried biomass fuels for energy in many years to come. Over the years, almost every tree species is used all over the world for fuelwood. In the forest zone (Southern Nigeria), the list of

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the crop species for fuelwood cannot be completed because different free species are available. Most of the species have been used for fuel wood as well as for moderation of the other wood products. In savanna zone (Northern Nigeria), more than 50 species are being harvested for fuelwood consumption as well as for production of other wood.[1] The supply of the fuelwood to those who need it today is by far lesser than the demand for it in Western and Eastern Africa, where the rural house hold gather fuelwood themselves while the town dwellers depend on it to a very large extent, and in some towns, almost entirely on purchased fuelwood and charcoal. The fuelwood consumed in most African countries especially Nigeria comes from the uncultivated bush, forest reserve, and plantation.

According to[6], the share of various sources in the primary energy supply in Nigeria is made up of oil – 10.4%; gas – 6%; hydro – 0.6%, and commercial renewable energy – 83%. The greater portion of the commercial renewable energy is wood, while other agricultural wastes constitute the remaining smaller portion. The over-dependence on fuelwood for energy is chiefly because of its relatively low price and easy accessibility.[7] Other reasons are the constraints in the supply of the convectional fuels and the growing population with a large segment still falling below income that cannot afford the cost of conventional fuels.[7] In two selected local government areas of Katsina State where there is a large poor population, poverty is the most significant parameter that derives extensive traditional use of fuelwood and residue.[6]

Nigeria is a country with large fuelwood deficit zones, mainly in the North, while in some Southern areas, production exceeds consumption.[1,8] These areas supply the deficit zones. Therefore, a balance between annual regrowth and consumption has to be struck on a national level. According to the forest resources assessment (FRA) Country Report's[9] that's Nigeria is having a total wood removal from the forests amounted to 86,626,797 m^3 and the removal for wood fuel from forests in the year 2005 was 72,710,935 m^3, the difference being made up by industrial round wood, which accounted for 13,915,862 m^3. However, wood may also come from areas outside the forests such as scrubland, savanna, and grassland as no other data are available on these sources in Nigeria. A reasonable estimate has to be made based on figures from neighboring countries. However, neither from neighboring Benin, Cameroon, or from Ghana data are available. The FRA 2005 Country Report from Senegal however present data on the growing stock on the other wood land[9] which allows to conclude that the growing stock on "other wooded land" is about 7% of the growing stock in forest. We assume the same percentage to be true for Nigeria. Adding 7% to 86,626,797 m^3 gives us 92,690,673 m^3 as the total harvest of wood from forest and other wood land combined. In Nigeria the shares of fuelwood proper and wood for making charcoal is not known. We assume it to be about the same as in Chad that is 78% and 22%, respectively of all the wood used energically.[10] About 80% of Nigerians reside in the rural areas, while over 90% of these rural dwellers use fuelwood for both domestic and industrial cooking.[5,11] Unchecked sourcing of fuelwood in developing countries results in various ecological problems such as deforestation, desert encroachment, desertification, soil erosion, ozone layer depletion, and climate change. This has been substantiated by various researchers.[1,5,12-14] The objective of this study is to investigate the desired tree species for fuel consumption in the two selected local government areas of Katsina State.

Figure 1: Map of Katsina state showing the study area

METHODOLOGY

Study Area

The study was conducted in two selected local government (Sabua and Faskari) areas of Katsina State [Figure 1].

Sabuwa Local Government Area

Sabuwa local government area is located on latitude 11°48'N and longitude 7°94'E of the equator. The local government shares boundaries with Dandume local government to the North and Faskari local government to the West. The local government has a projected population of 136,050 people (NPC, 2006). It has 400–1100 mm of rainfall per year, maximum temperature of 41°C and minimum at 22°C with a maximum wind speed of 14 km/h.[15]

Faskari Local Government Area

Faskari local government is located on latitude 11°48'N and longitude 71°42'E of the equator. The local government shares boundary with Bakori to the East Sabuwa and Dandume to

the South. The local government has projected population of 196,035 people with an annual rainfall between 400 mm and 11000 mm and average raining day between 90 and 100 with maximum temperature of 41°C and a minimum of 22° (NPC, 2006). The local government has maximum wind speed of 14 km/h with relative humidity of 73/14.[15] The people in the local government are farmers and grown crops such as cowpea, sugarcane, rice, and sorghum.[15]

Data Collection and Source

Primary and secondary data were used for this study. The primary data were collected through the use of questionnaires while the secondary data were collected through the use of journals, textbooks, conference proceedings, etc. The questionnaire for the primary data was designed to elicit the following information:

i. Socioeconomic characteristics of sampled respondents such as age, sex, marital status, and education background.
ii. Species most favored and reasons for their selections
iii. Sources of fuel wood supply to the respondents
iv. Reason for selectivity, etc.

Sampling Procedure

A total of 120 questionnaires were randomly administered in the selected two local government areas with each having 30 questionnaires. One hundred questionnaires were retrieved. The two LGAs were selected on the basis of the high rate of poverty level and deforestation due to non-availability and high cost of kerosene and cooking gas in the areas.

Analytical Techniques

The following analytical tools were used to analyze the data collected:

i. Descriptive statistics
ii. Formular to calculate consumption per head, per year.

Determination of Fuel Wood Consumption

Head/year in each of the local government areas was calculated using the formula below:

1. $C/h/y = NW_{GI} X PL_G$
2. Where C/h/y = fuel-wood consumption/head/year
3. NW_{GI} = National fuel-wood Consumption per head index
4. PL_G = Population of each selected local government areas

RESULTS AND DISCUSSION

Socioeconomic Characteristic of Respondents

Some socioeconomic characteristics are known to influence tree species for fuelwood consumption in the selected local government area of Katsina State. The variable analyzed includes: Age, marital status, gender, and educational status.

Table 1 revealed that 39.0% of the respondents were between the age brackets of 31–40 years. This implies that they are at the middle and economically active age which could have positive effect on their standard of living[1] and observed that age bracket has a positive influence on preference of fuelwood

Table 1: Socioeconomic characteristic of sampled respondents

Variable	Respondents	Percentage
Age in years		
10–20	12	12.0
21–30	18	18.0
31–40	39	39.0
41–50	16	16.0
51 and above	15	15.0
Marital status		
Married	50	50.0
Single	20	20.0
Divorced	10	10.0
Widowed	12	12.0
Widower	8	8.0
Gender		
Male	68	68.0
Female	32	32.0
Educational level		
Primary	37	37.0
Secondary	12	12.0
Tertiary	10	10.0
Quranic	15	15.0
No formal education	26	26.0
House hold size		
1–2	04	4.0
3–4	15	15.0
5–6	25	25.0
7–8	35	35.0
10 and above	21	21.0
Occupation		
Farmers	42	42.0
Civil servant	10	10.0
Business	30	30.0
Others	18	18.0
Total	100	100.0

Table 2: Sources of fuel wood supply of sampled respondents

S. No.	Sources	Respondents	Percentage
1	Market	20	20.0
2	Wood lot	10	10.0
3	Forest	70	70.0
	Total	100	100.0

Table 3: Determination of fuelwood consumption/head/year

S. No.	Selected local government areas	Natural consumption per head/index (t/person/year)	Population of each local government areas	Consumption head of each local government (t/p/year)	Area (km^2)	Density (pop/km^2)
1	Sabuwa	0.284	136050	38.64	642	212
2	Faskari	0.284	196035	55.67	1750	112

species. About 50% of sampled respondents are married while 25% are single. About 68% are male while 32% are female. About 37% of the respondents had primary school education, 26% had no form of formal education, 15% had Quranic education, 12% had secondary school education, and 10% had tertiary education. This indicates that a great percentage of the respondents in the selected local government area of Katsina State had formal education at various levels. This finding has therefore reflected the importance of education in preference of fuelwood species[16] observed that the more individuals are exposed to any form of education, the more likely they will have a better understanding of their environment. However, 35% of the respondents (majority) had a household size of 7–8, 25% have 5–6, 21% had 10 and above which implies high consumption of fuelwood.

Sources of Fuelwood Supply of Respondents

Various sources of fuelwood supplied to the respondents were observed to influence the preference of the species for fuelwood consumption in the selected study site. The variable analyzed includes: Market, wood lot, and forests.

Table 2 above revealed that 70% of the fuelwood consumed in the study area comes from the natural forest, 20% of the fuelwood are purchased from the market while only 10% comes from wood lots. The percentage from the wood lots is minute because neither community forest nor private forest was involved in the supply of fuelwood. This might be attributed to lack of technical knowhow, level of education, etc. which resulted in non-engagement in commercial tree planting and wrong timing in forestry planting programs. However, many of the existing natural forest were being depleted due to the pressure by fuelwood collectors to meet the ever rising demand of fuelwood for domestic uses (cooking). This corroborates with the observation made by[17] that the overharvesting of forest (fuelwood) increases with the scale of people's needs.

Fuelwood Consumption/Head/year Determination in Selected Local Government Area of Katsina State.

This is calculated using the formula below:

$$C/h/y = NW_{GI} \times PL_{G}$$

Where,
C/h/y = Fuel consumption/head/year
NW_{GI} = National fuelwood consumption per head index

Table 4: Use of alternative source of energy

S. No.	Sources	Respondents	Percentage
1	Fuelwood	83	83
2	Kerosene	10	10
3	Electricity	5	5
4	Gas	2	2
	Total	100	100

PL_{G} = Population of each selected local government
Table 3 revealed that Faskari Local Government consumed more fuelwood/head/year (55.67 t/person/year) than Sabuwa Local Goverrnment (38.64 t/person/year). The population of each local government area used was based on the census of 2006.

However, there are direct relationships between human population and wood fuel demand; hence, the cutting down of wet wood can be said to be on the increase. The rate of consumption of fuelwood in Nigeria exceeds the rate of production.[15] It is therefore right to say this renewable source of energy would sooner or later be scarce, should this form of exploitation continue.

Uses of Alternative Source of Energy

Alternative source of energy in the selected local environment was also analyzed. The alternative types of energy assets include: Fuelwood, kerosene, electricity, and gas.

Table 4 shows that majority of the respondent (83%) are using fuelwood as source of energy. About 10% uses kerosene, 5% electricity, and 2% uses gas. Reason given by the respondents is that fuel-wood is a free gift of nature, very cheap, and easily to come-by compared to other sources of energy.

Respondents Preferred Tree Species for Fuelwood Consumption

Preferred tree species for fuel consumption in the selected local government areas were analyzed. Some of the factors considered for the selection include:

i. Fire retaining capacity of the wood (low/high)
ii. Smoke ability of the wood (low/high)
iii. Fire holding capacity of the wood (low/high)
iv. Availability (readily, scarce, available, etc.).

Table 5 revealed that *Isoberlinia doka* was the most preferred (24%) tree species for fuelwood consumption. The selection

Table 5: Respondent's preferred tree species for fuelwood consumption

S. No.	Botanical name	Local name (hausa)	Respondents	Percentage	Reasons for preference
1	*Isoberlinia doka*	Doka	24	24	High fire retaining capacity, low smoke, low moisture holding capacity
2	*Acacia* species	Acacia	12	12	High fire retaining capacity, low smoke, low moisture holding capacity
3	*Tamarindus indica*	Gundagura	8	8	Low fire retaining capacity, low smoke, high moisture holding capacity
4	*Ficus* species	Dulu	4	4	Low smoke, low fire holding capacity
5	*Eucalyptus* species	Tuari	15	15	High moisture holding capacity
6	*Khaya senegalensis*	Mahogany	5	5	Low smoke, low fire holding capacity
7	*Butyrospermum paradoxum*	Dyiya	5	5	High fire retaining capacity, low smoke, low moisture holding capacity
8	*Anogeissus leiocarpa*	Merike	7	7	High fire retaining capacity, low smoke, low moisture holding capacity
9	*Danielia oliveri*	Ogea	8	8	Low fire retaining capacity, low smoke, high moisture holding capacity
10	*Cassia* species	*Cassia*	3	3	Low smoke, low fire holding capacity
11	*Prosopis oblonga*	Kiriya	6	6	Low fire retaining capacity, low smoke, high moisture holding capacity

of the tree species was attributed to its high fire retaining capacity, low smoke, and low moisture holding capacity. The characteristic of the selection is in accordance with.[18] This species is closely followed by *Eucalyptus* species (15%) and *Acacia* species (12%) while *Cassia* species is the least preferred with 3% each.

CONCLUSION

I. doka, *Acacia* species, and *Eucalyptus* species are the most preferred tree species for fuelwood in the study areas. The preference of these was due to their high level of fuel, low smoke level, density, and ease of establishment. Alternative sources of energy are either too costly or not available which makes majority of the people to rely solely on fuelwood consumption. Quantity of the fuelwood consumed/head/year in each of the selected local government is an indication that people had inherited the habit of fuelwood consumption which makes it difficult for them to accept changes easily. However, majority of the fuelwood collected was from the natural forest and only a few people replaced the trees after cutting. It is therefore recommended other alternative sources of energy such as use of kerosene stove, gas cooker, and solar should be encouraged and subsidized to reduce pressure on the forest estate (fuelwood). There is a need for artificial regeneration of tree species exploited in the form of woodlots, community forest plantation, etc. for continuous supply of fuelwood on a sustained basis. Farmers should be encouraged to interplant forest crops with forest trees in the form of agroforestry system to increase supply of fuelwood to the general populace, more funds should be channeled to the forestry sectors through their relevant ministry and Forest Research Institute for establishment and management of fast growing tree crops for woodlots.

REFERENCES

1. Sodimu AI, Ajala OO, Oladele NO, Adewunmi DD. Survey of the most favoured trees species for fuelwood consumption in Kaduna state, Nigeria. Niger J Forest 2003;33:53-7.
2. Akachukwu AE. Wood as a Source of Forestry for National Development. In: Proceedings of the Paper Presented at the 27th Forestry Association of Nigeria Conference held at Federal Capital Territory, Abuja; 2001. p. 201-13.
3. Food and Agriculture Organization. The Role of Woodfuel in Africa by D. Gustafon. In: Wamukonye N, editor. Proceeding of a high level Regional Meeting on Energy and Sustenance Development held in Nairobi, Kenya. Rome: Food and Agriculture Organization of the United Nations; 2001. p. 99-101.
4. Zaku SG, Kabir A, Tukur AA, Jimento IG. Wood fuel consumption in Nigeria and the energy ladder: A review of fuelwood use in Kaduna State. Acad J 2013;4:85-9.
5. Ogunsanwo OY, Ajala OO. Firewood Crisis in Lagos: Implication on Sub-Urban and Rural Ecosystem Management. In: Proceedings of the 28th Annual Conference of the Forestry Association of Nigeria; 2002. p. 402-8.
6. United Nations Development Programme. World Energy Assessment. United Nations Development Programme, United Nations Development of Economic and Social Affairs and World Energy Control. New York: United Nations Development Programme; 2007. p. 15.
7. Adebayo AG. Gender roles in forest resources utilization and its impact on rural environment in Kwara State, Nigeria. In:

Environmental Sustainability and Conservation in Nigeria. Akure, Nigeria: Federal University of Technology; 2005. p. 16.
8. Ogbonna DO. Energy Challenge and Ecological Balance in the Sahel and Semi-Arid Zone of Nigeria. A Paper Presented at the International Workshop on Ecology and Society in the History of the Sahel and Savanna, Centre for Trans-Saharan Studies, University of Maiduguri; 1991. p. 20.
9. Food and Agriculture Organization. Global Forest Resources Assessment. FAO Forestry paper 147. Progress towards Sustenance Forest Management. Rome, Italy: Food and Agriculture Organization; 2005. Available from: https://www.Ftp//ftp.org/docrep/fao/008/A0400E.Pdf [Last accessed on 2016 Jul 06].
10. Kituyi E. Towards Sustainable Charcoal Production and Use: A Systems Approach." In: Proceedings of a Regional Workshop on Woodfuel Policy and Legislation in Eastern and Southern Africa, RECMA, Nairobi, Kenya; 2002. p. 17.
11. World Bank. Poverty and Welfare in Nigeria. World Bank News Bulletin Edited by American Writing Corporation. Washington DC: World Bank; 1992. p. 22.
12. Adegbehin JO. Procurement of Fuelwood using Forest Growing Species. In: Proceedings of the Paper Presented at the Annual Conference of Forestry Association of Nigeria; 1992. p. 46-53.
13. Adedire MO. Environmental Protection: The Agroforestry Option. In: Proceedings of the Paper Presented at the 22nd Annual Conference of Forestry Association of Nigeria; 1992. p. 194-200.
14. Amaza PS. The Demand and Supply for Fuelwood: Implications for Forest Conservation in Nigeria. In: Proceedings of the Paper Presented at the 26th Forestry Association of Nigeria; 1999. p. 91-10.
15. Zaku SG, Kabir A, Tukur AA, Jimento IG. Wood fuel consumption in Nigeria and the energy ladder: A review of fuel wood use in Kaduna State. J Pet Technol Altern Fuels 2013;4:85-9.
16. Zira BD, Boni PG. Profitability analysis of *Moringa* (*Moringa oleifera*) production in central Adamawa, Nigeria. In: Isah AD, Shamaki SB, Adekunle V, Bello AG editors. Proceeding of Paper Presented at the 6th Biennial National Conference of the Forest and Forest Products Society. Sokoto, Nigeria: Usmanu Danfodiyo University; 2018. p. 412-6.
17. Abdullahi S, Bunza MS, Mukhtar RB, Magaji K. Fuel Wood Consumption Pattern of Rural Communities Sabuwa, Sokoto State. Proceedings of 6th Biennial National Conference of the Forest and Forest Products Society of Nigeria, held on 23rd-27th April, Sokoto, Nigeria; 2018. p. 417-21.
18. Food and Agriculture Organization. Global Forestry Products: Consumption, Production, Trade and Prices: Global Forest Products Projections to 2010. Rome: Food and Agriculture Organization; 1999. p. 333.