Perceived environmental effects of charcoal production among rural dwellers in rainforest and Guinea Savannah Agro-ecological zones of Nigeria

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ABSTRACT

Charcoal production constitutes serious environmental problems to most developing countries of the world. Hence, this study assessed perceived environmental effects of charcoal production among the rural dwellers in rainforest and guinea savannah zones of Nigeria. Multi-stage sampling procedure was used to select 83 and 85 charcoal producers in guinea savannah and rainforest zones, respectively. Data was collected through the use of structured interview schedule and analysed using both descriptive and inferential statistics. Results show that the mean age was 43 years, 90.5% were males, 90.6% were married. Majority (80.0%) of the respondents made use of earth mound method of charcoal production and 52.9% of respondents produced between 32-32000kg of charcoal per annum. Most respondents (62.7%) perceived that charcoal production could lead to erosion, 62.4% reduce the available trees for future use (62.4%) and reduce available air in the environment (54.1%). While 51.8% perceived that micro organism may not be threatened because of charcoal production activities. Significant difference existed in the perceived environmental effects of charcoal production between rainforest and guinea savannah agro-ecological zones (F=14.62). There is need for the government to quickly work on other available and affordable alternative household energy sources.

Keywords*:* Deforestation, Energy, Earth mound method, Charcoal production

INTRODUCTION

The link between forests and provision of energy is obvious all over the world since forests provide food, fuel wood for cooking, herbs, and medicine. Moreover, forests make the most direct contribution to the goals of eradication of poverty and hunger as well as environmental sustainability in the rural areas. Forests have an indirect role in meeting the Millennium Development Goals (MDGs). This is through the socio-economic and environmental functions of the goals. A large gap exists between the demand and supply of energy in Nigeria, because nearly 70% of the populace are involved in subsistence-based ventures and live in the rural communities (World Bank, 2004). Thus, reliance on natural resources for food and energy implies that people source for their daily needs from their immediate environment (World Bank, 2002). Half of the world's population use biomass fuels for cooking and heating, this made the world's production of fuelwood to increase between 1970 and 1995 from 1362.4 million M^3 to 1875.9 million[3](Carney, 1998).

In charcoal production, Nigeria tops the list in Africa with 2314797 tonnes (10^5) in 1992 and 3776300 tonnes (10^5) in 2009 (FAO, 2010). This implies that most African countries, especially Nigeria, still produce and use charcoal without developing modern and sustainable means of getting energy. High dependence on the production and use of charcoal has resulted into environmental degradations during production (Guo, 2007). It is also estimated that about 32 million cubic metres of fuel-wood is consumed in the rural areas of Nigeria annually despite the environmental hazards (Federal Ministry of Environment, 2006).

Deforestation as a result of charcoal production has negative implications for the local environment (increased erosion) and the global environment (acceleration of climate change, threatened biodiversity). The reduction of forest cover also reduces the existing capacity to sequester carbon, and release the already fixed carbon. For instance, the impact of charcoal on forest reserves is devastating for two reasons. First, the wood fuel equivalent is 4-6 times larger, due to the inefficiency of the production process (SEI, 2002). Before, the bulk of charcoal wood is clear-cut from secondary, but now, mainly from primary forests. Emissions during charcoal production are significant. Hence, charcoal leads to considerable deforestation, which is now one of the most pressing environmental problems faced by most African nations including reduction of natural resources on which the poor depend, and land degradation (Friends of the Earth, 2002).

Many African nations have had over three quarters of their forest cover depleted. Moreover, the global warming potential of current and largely inefficient methods of charcoal production (pyrolysis) is

considered to be higher than that of emissions during combustion (IFAD, 2009). Wood is taken illegally from land and producers are under pressure to harvest the wood and make the charcoal as fast as possible. The rural firewood users typically collect small amounts of wood daily, and thus the forestry impact is dispersed and much less severe than the effects of charcoal production.

Despite the laws promulgated by the Federal Government prohibiting illegal felling of trees, charcoal producers keep increasing with an increase in the quantity of charcoal produced. Charcoal production is very prominent in Osun, Ogun, Benue, Kogi, and Niger States of Nigeria where there are forests, and guinea belts that support its production.

However, the potentials of these agro-ecological zones to support charcoal production differ. Raw materials sourcing are major source of environmental depreciation associated with charcoal production. For instance, before now, in the rainforest zone, forest trunks, off-cuts from logs over lands and twigs constitute the materials for charcoal production. Often, deliberate felling of trees and shrubs are the usual practices in the derived and pure savannah. It is pertinent, therefore, to examine various issues of charcoal production and their effects on the environment of charcoal producing communities.

Objectives of the study

The general objective of the study was to assess the perceived environmental effects of charcoal production among the rural dwellers in rainforest and guinea savannah zones of Nigeria.

The specific objectives were to: identify the selected socio-economic characteristics of charcoal producers in the study area; determine the methods used in charcoal production; determine the level of charcoal production; and ascertain the perceived effects of charcoal production on the environment in rural dwellers.

METHODOLOGY

The study area was the rainforest and guinea savannah zones of Nigeria. Nigeria is located between latitudes 4 ^{o} to 14^{o} North and between longitudes 2^{o}2' and 14 ^{o} 30' East. It has a land area of about 923 769 km^{2}. Its total land boundary is 4, 047 km while the coastline is 853 km. The Federal Ministry of Environment of Nigeria (FMEN, 2001) 1993 estimate of irrigated land is 9, 570 km^{2} and arable land about 35 %; 15 % pasture; 10 % forest reserve; 10 % for settlements and the remaining 30 % considered uncultivable for one reason or the other (Iloeje, 2001). Rainfall varies from place to place and from season to season. The total annual rainfall decreases from the south to the north. The southern two-thirds of the country have double peak rainfall while the northern third has a single peak. Similarly annual rainfall totals range from 2,500 mm in the south to less than 400 mm in parts of the extreme north (FMEN, 2001).

Multi-stage sampling procedure was used to select respondents from the population of charcoal producers. From the six agro-ecological zones in Nigeria, rainforest and guinea savannah zone were purposively selected because of their potentials in charcoal production. Fifty percent of rural communities in the zone were selected using simple random sampling technique. Thirty percent of the registered charcoal producers were selected from the population of all registered charcoal producers available in each of the selected communities using simple random sampling technique. A total of eighty three and eighty five charcoal producers were used as respondents in guinea savannah and rainforest zones, respectively for this study. A Likert-type five point rating scale of "strongly agree" to "strongly disagree" (with scores 5-1 for positively worded statements and 1-5 for negatively worded statements respectively), with 18 statement used to asses respondents' perception of environmental effects of charcoal production. Respondents were requested to indicate their opinion on each of the 18 selected statements (nine positive, and nine negative).

RESULTS AND DISCUSSION

Socioeconomic characteristics of charcoal producers

Table 1 indicates that respondents mean age was of 43 years. Across agro-ecological zones, the modal ages were within the same age-range of between 35 and 44 years with 35.1% and 48.1% of respondents in rainforest and guinea savannah zones, respectively belongs to these age range. This shows that they are in their productive ages. This result is in consonance with the study of Stockholm Environment Institute (SEI) (2002), which reported that charcoal production appears to be dominated by the active age-range of between 35 and 45years. Sex is a vital variable on issues relating to livelihood strategies. Majority (88.0% in rainforest and 90.5% in guinea savannah) of respondents were males. The percentage of female respondents is relatively small when compared with their male counterparts. This may be as a result of the rigour involved in some of the activities of charcoal production. This finding agrees with SEI (2002), which revealed that males are more involved in charcoal production. Also in a related study by Charcoal production in South Africa (CHAPOSA)

(2002), it was revealed that 70.0% of charcoal producers were males. Majority of respondents (90.4% in rainforest and 90.6% in the guinea savannah) were married. This implies that a lot of money is realised from the sale of charcoal, which enables those who are married among them to cope with financial responsibilities in their families. Data across the zones reveal that more respondents (59.0%) in the rainforest zone possessed primary school certificate, while, 30.6% of respondents in the guinea savannah attended Quranic School. In the rainforest zone, 54.2% of respondents and 49.4% in guinea savannah had crop farming as primary occupation. Inability to produce charcoal all round the year may prevent some of the producers not to take it as primary occupation. Shacklon *et al* (2006), in a related study, noted that those who have farming as their primary income generating activity have the tendency to be involved in charcoal production because they clear lands which provide easy access to wood for charcoal production. SEI (2002) revealed that only those with required vegetation take charcoal production as their primary occupation. However, across vegetation zones, 81.9% and 82.4% are charcoal producers in the forest and guinea savannah zones, respectively. Charcoal production is, therefore, an activity for income diversification (Barret, *et al*, 2001and UNDP, 2005). Olawoye (2000) also opined that many households engage in several income-generating activities in order to meet their household needs. In order to meet household needs, other sources of income are required. Across the agro-ecological zone, the mean years of experience are 11 for the rainforest zone and 14 guinea savannah zones. Across agro-ecological zones, mean income for rainforest is N190,421.9 (1,269.5 dollar) SD of 55819.4 and N135,929.4 (906.2 dollar) with SD of 559,11.4 for the guinea savannah. Kalumiana (2000) opined that 70.0% of the cash income realised annually in Tanzania was realised in an area suitable for charcoal production.

Table 1: Distribution of charcoal producers by their socio-economic characteristics

Socio-economic characteristics	Guinea savannah Freq.	%	Rainforest zone Freq.	%
Age (Years)	Age Mean=43, SD=8.0		Age Mean=43, SD=8.0	
25-34	8	9.5	7	8.4
35-44	41	48.1	29	35.0
45-54	26	30.5	26	31.3
More than54	10	11.9	-	-
Sex				
Male	77	90.5	73	88.0
Female	8	9.5	10	12.0
Educational Attainment				
Non formal educ.	30	35.3	14	16.9
Koranic school	26	30.0	7	8.4
Pry. School	17	20.6	49	59.0
Sec. school and above	12	14.1	11	15.7
Marital status				
Married	77	90.6	75	90.4
Single	5	5.9	5	6.0
Widow	2	2.3	3	3.6
Divorced	1	1.2	-	-
Primary occupation				
Crop farming	42	49.4	45	54.2
Fishing	30	35.3	9	10.8
Charcoal production	12	14.1	11	13.3
Trading	1	1.2	14	16.9
			4	4.8
Sec. occupation				
Crop farming	14	16.4	10	12.0
Charcoal production	70	82.4	68	81.9
Weaving	1	1.2	1	1.2
Hunting			4	4.9
Years of experience	**M=14 SD=4.2**		**M=11 SD=4.3**	
<5years	6	7.1	9	10.8
6-10	6	7.1	16	19.4

Socio-economic characteristics	Guinea savannah Freq.	%	Rainforest zone Freq.	%
11-15	39	45.8	51	61.4
>15	34	40.0	7	8.4
Annual income from charcoal production	**M=217,336.4 SD=99,571.4**		**M=190,421.9 SD=99571.4**	
Less or equal ₦100.000.00	20	23.5	-	-
100.001-200.000.00	48	56.5	38	45.8
200.001-300.000.00	16	18.8	40	48.1
300.001400.000.00	1	1.2	5	6.1

Methods of charcoal production

Table 2 shows that majority (100.0% and 80.0%) of the respondents made use of earth mound method of charcoal production in rainforest and guinea savannah zone, respectively; while, 20.0% make use of the pit method in guinea savannah zone. This suggests that earth mound is very prominent in the zones. In a related study by Bada *et al* (2009), surface (earth mound) method was found to be the most commonly used method of charcoal production in many parts of Nigeria.

Table 2: Distribution of respondents based on methods of charcoal production

Methods used in charcoal production	Rainforest zone		Guinea savannah	
Earth mound	83	100.0	68	80.0
Pit method	-	-	17	20.0
Total	83	100.0	85	100.0

Respondents' annual output from charcoal production

Table 3 reveals that 52.9% of the respondents produced between 32-32000kg of charcoal per annum while, 41.2% produced between 32032-64000kg in guinea savannah. However, 36.1% produced greater than 128000kg/annum in rainforest zone. CHAPOSA (2002) inferred that the output from charcoal production depends on the season, availability of water, types of wood, vegetation and occupation of the producer.

Table 3: Distribution of respondents based on the annual output from charcoal production in the selected ecological zones

Kilogram of charcoal	Rainforest zone		Guinea savannah	
Total quantity per annum	F	%	F	%
32 – 32000kg	11	13.3	45	52.9
32032– 64000	13	15.6	35	41.2
64032– 96000	25	30.1	-	-
96032-128000	5	4.9	1	1.2
More than 128000	30	36.1	4	4.7
Total	83	100.0	85	100.0

Perceived effects of charcoal production on the environment in the rainforest zone

Table 4 reveals that majority (75.9%, and 63.4%) of respondents in the rainforest zone strongly agreed respectively that continuous involvement in charcoal production may reduce the available trees for future use and that if charcoal production continues it may reduce crop production. Many respondents (51.8%, 55.4% and 61.4%) strongly agreed respectively that micro organisms may not be threatened because of charcoal production, charcoal production may have negative effects on the fertility of agricultural land and that charcoal production could not lead to deforestation.

Table 5 also reveals that 64.7%, 62.4% and 55.3% of the respondents in the guinea savannah strongly agreed respectively that charcoal production could lead to erosion, continues involvement in charcoal production may reduce the available trees for future use and that if charcoal production continues it may reduce production of crops. In addition, 54.1%, 47.1% and 44.7% savannah strongly agreed respectively that charcoal production may reduce available air in the environment; charcoal production may reduce water availability in the

environment and may have negative effects on the fertility of agricultural lands respectively.

This implies that the respondents perceived that charcoal production may have negative effects on the fertility of agriculture land, lead to deforestation, reduce the available trees for future use, reduce organic matter and micro-organisms in the soil, reduce crop production, soil fertility could be enhanced by replanting cut trees and having more trees on land may improve that quality of air and water. Friends of the Earth, (2002), Makhabane (2002), Songsore, (2003), Kammen *et. al.* (2005), UNDP (2005), GTZHERA (2009), Ottu-Danquah (2010), and Msuya, *et. al.*(2011) noted that in most African countries where charcoal production is predominant, problems and challenges such as ecosystem degradation; deforestation, increased erosion, infertile land, low crop yield, acceleration of climate change, threatened biodiversity exist.

Table 4: Distribution of the respondents according to perceived effects of charcoal production on the environment, Rainforest zone N=83

Statements on environmental related problems	SA	A	U	D	SD
Charcoal production could not lead to deforestation	61.4	1.2	-	7.2	30.1
Charcoal production may have negative effects on the fertility of agricultural land	55.4	8.4	-	26.5	9.6
Continuous involvement in charcoal production may reduce the available trees for future use.	75.9	20.5	-	3.6	-
Charcoal production may not lead to immense land degradation.	4.4	33.7	-	4.8	56.6
Charcoal production could expose land to erosion	7.2	12.0	-	7.2	73.5
Charcoal production may encourage quick regeneration of plants	1.2	8.4	-	28.9	60.2
Charcoal production may reduce water availability in the environment	22.9	1.2	1.2	6.0	53.0
Micro-organisms may not be threatened because of charcoal production activities	51.8	16.9	1.2	18.1	22.9
Flooding is not always enhanced during charcoal production	66.3	7.2	-	2.24	8.4
Charcoal production may reduce air availability in the environment	44.6	22.9	-	1.2	37.3
Charcoal production could increase organic matter in the soil	3.6	16.9	-	27.7	66.3
Ashes from charcoal kiln can be useful to the environment	8.4	2.4	-	24.1	63.9
If charcoal production continues it may reduce production of crops	63.4	3.6	-	1.2	4.8
Soil fertility could be enhanced by not replanting cut trees	6.0	30.1	-	24.1	69.9
Having more trees on land may not improve the quality of air and water	4.8	1.2	-	26.5	67.5
Movement of lorries on lands during charcoal production may not compact the soil	47.0	20.5	-	31.3	1.2
Charcoal production may not necessarily change rainfall pattern	38.6	1.2	-	24.1	36.1
Charcoal production could increase the fertility of soil	10.8	7.2	2.4	14.5	65.1

T**able 5: Distribution of the respondents according to perceived effects of charcoal production on the environment, Guinea savannah zone N=85**

Statements on environmental related problems	SA	A	U	D	SD
Charcoal production could not lead to deforestation	27.1	3.5	0.0	30.6	38.8
Charcoal production may have negative effects on the fertility of agricultural land	44.7	11.8	2.4	22.4	18.8
Continuous involvement in charcoal production may reduce the available trees for future use.	62.4	37.6	0.0	0.0	0.0
Charcoal production may not lead to immense land degradation.	37.6	22.9	0.0	14.1	24.4
Charcoal production could expose land to erosion	64.7	8.2	1.2	4.7	21.2
Charcoal production may encourage quick regeneration of plants	18.8	8.2	1.2	28.2	43.5
Charcoal production may reduce water availability in the environment	47.1	27.1	0.0	4.7	21.2
Micro-organisms may not be threatened because of charcoal production activities	22.4	4.7	0.0	25.9	47.1
Flooding is not always enhanced during charcoal production	2.4	32.9	1.2	3.5	60.0
Charcoal production may reduce air availability in the environment	54.1	23.5	0.0	3.5	18.8
Charcoal production could increase organic matter in the soil	2.4	0.0	0.0	45.9	51.8
Ashes from charcoal kiln can be useful to the environment	4.7	8.2	0.0	32.9	54.1

Statements on environmental related problems	SA	A	U	D	SD
If charcoal production continues it may reduce production of crops	55.3	37.6	0.0	2.4	4.7
Soil fertility could be enhanced by not replanting cut trees	0.0	2.4	0.0	29.4	68.2
Having more trees on land may not improve the quality of air and water	0.0	1.2	0.0	44.7	54.1
Movement of lorries on lands during charcoal production may not compact the soil	17.6	1.2	0.0	34.1	47.1
Charcoal production may not necessarily change rainfall pattern	18.8	2.4	0.0	41.2	37.6
Charcoal production could increase the fertility of soil	18.8	20.7	1.2	16.5	43.5

Test of difference in the perceived environmental effects of charcoal production across the agro-ecological zones

Table 6 reveals that there was a significant difference in the perceived environmental effects of charcoal production across the agro-ecological zones (F=14.62). Guinea savannah has a higher perception of the effects of charcoal production on the environment (47.894). The sparsely distributed trees in the guinea savannah coupled with fetching of trees for charcoal production in the zone will lead to greater effects on the environment. The rainforest zone with low mean (39.482) and perceived effects of charcoal production on the environment imply that the environmental effects of charcoal production are lower in this zone. This result is in consonance with the study of Seidel (2008) that the more men move away from the swampy rainforest zone to the savannah in search of forest resources, the more the effects on human beings and on the environment. This could be as a result of high demand for forest trees.

Table 6: Differences in the level of perceived environmental effects of charcoal production across the agro-ecological zones

Parameter	Statistical tool	Df	Sum of square	Mean square	F value	p value	Decision
Perceived environmental effects of charcoal production	Analysis of variance	2	3233.185	1616	16.66	0.00	Significant

Duncan's Multiple Range Test

Duncan Grouping	Mean	N	Zone
	47.894_a	85	Guinea savannah
	39.482_b	83	Rainforest

Letters that are the same are not significantly different

RECOMMENDATIONS

Since, charcoal production may have negative effects on the fertility of agriculture land, lead to deforestation, reduce the available trees for future use, reduce organic matter and micro-organisms in the soil and reduce crop production. It is recommended that natural resources management measures through enforcement of the law that guide the use of the forest resources such as law that will recommend selective/controlled felling of trees be encouraged. In view of the environmental hazards as well as huge benefit accrued from charcoal production by the rural dwellers, there is need for the government to quickly work on other available and affordable alternative household energy sources such as kerosene, solar energy, gas, and uninterrupted electricity as well as alternative sources of income to rural dwellers.

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