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Rural dwellers involvement in charcoal production in three agro-ecological zones of Nigeria

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Abstract
Quick income from charcoal has encouraged many rural dwellers to involve in its production in Nigeria. Involvement in charcoal production (CP) is a factor that constitute to large scale production among rural dwellers. Therefore, involvement in charcoal production among rural dwellers in three agro-ecological zones of Nigeria was investigated. A total of 327 charcoal producers in the three selected agro-ecological zones were selected through multi stage sampling procedure. Structured interview schedule responses were analysed using both descriptive and inferential statistics. Findings reflected the same age-range of between 35 and 44 years. Majorities (88.0% and 92.0%) of respondents were males and married respectively. Most (63.7%) of the respondents had formal education. Less than 50.0% of respondents took CP as primary occupation with average years of experience of 13 ±4.9. Almost 100.0% of the respondents made use of earth mound method of CP in the study area. Across the agro-ecological zones, 51.6% in derived savannah (DS) and 60.0% in guinea savannah (GS) had high level of involvement in the stages of CP while only 39.8percent of respondents in the rainforest (RF) zone had high level of involvement in the stages of CP. There was a significant difference in level of involvement in the various stages of CP across the agro-ecological zones (F = 34.848). Livelihood activities such as fishery, bee keeping, snailery, and horticulture that could reduce their involvement in CP should be encouraged.

Keywords: Charcoal production, earthen mound method, involvement, rural dwellers

Introduction
Nigeria is an energy-resource rich country blessed with crude-oil, natural gas and energy resources such as solar, wind, biomass, biogas, etc. The country is also rich in human resource with a total population of 140 million according to the 2006 population census and an annual population growth rate of about 2.8%. The national energy supply is at present almost entirely dependent on fossil fuels and fuelwood. For instance, the value of the charcoal market for 26 sub-Saharan African countries, for which there is known data, exceeds $1.8 billion per year (Akinbami, 2001) [1]. In energy terms, charcoal consumption in many African countries is higher than gross electricity consumption.
Charcoal has its importance in the following areas. It is a source of considerable amount of employment in rural areas. It allows for quick returns on investments (Stefan, 2009) [9]. About 65% of people in the rural areas have made fuelwood and charcoal production a source of income (Akinbami, 2001) [1]. The income from charcoal represented a per capita income of USD 24 and 14 in 1990 and 2000, respectively, which were 1.8 and 4.8 times the per capita income from the sale of agricultural produce in the same years. From the rural survey, it was estimated that annual production in some countries is 160 bags per producer while some produce significantly more than 500 bags. Also, income from charcoal is used to purchase food for households, agricultural inputs and farm implements. Charcoal production has also been found to be one of the largest economic activities in some countries of Africa after agriculture but generates more revenue for the rural dwellers than agriculture (Williams, 1993) [11]. It serves as a source of subsidy for crop production (Saket, 1994) [7]. Charcoal is vital to basic welfare and economic activity in developing nations, especially in sub-Saharan Africa (SSA), where they meet more than 90% of household energy needs in many nations. Charcoal is used in African art to design various objects (World Energy Council, 2004) [12]. Supply of charcoal as raw material in the manufacture of gunpowder, industrial fuel, automotive fuel, purification/filtration, to the cottage industries has also been the main reason why several individuals have continued to produce charcoal. It is also used by blacksmiths and for other industrial applications (Chris, 2007) [4]. This has greatly influenced the standard of living of rural people who do not have access to agricultural

inputs and finances to boost agriculture. The forestry sector employs about 2 million people, (mostly part-time); to supply fuelwood and poles and about 75,000 people in the industrial sector processing logs. This represents over one quarter of the labour force in the manufacturing industry. At present, the wood industries still rank very high, employing about 44.3% of the manufacturing labour force. An unquantified proportion of the rural population is involved in daily and routine gathering, processing and marketing of such forest products as nuts, mushrooms, honey, fruits, bushmeat, fish, fodder, fibre, spices, resins, gums, tannins, medicinal plants and fuelwood.

Charcoal production is found to be a tedious activity as result of the complex stages it involves. According to SEI (2002), the following are the stages involved in the production. Selection of site for kiln construction; tree felling; cross cutting into short logs; wood drying; kiln base structure; stacking logs; kiln insulation with grass and soil; ignite kiln; carbonisation control; cooling period; sorting of charcoal; packing into bags; and transport to road. Thus different people involve at different stages of charcoal production and this influence the quantity and quality of output that could be expected. It will therefore be worthwhile to assess the level of involvement in charcoal production in different agro-ecological zones of Nigeria.

Methodology

The study area is Nigeria. It is found in West Africa and lies between longitudes 3^0 C and 14^0 C and latitudes 4^0 C and 140^0 C. Nigeria has a land mass of 923,768 sq.km. It is bordered to the North by the Republic of Niger and Chad. It shares borders to the West with the Republic of Benin, while the Republic of Cameroun shares the eastern borders right down to the shores of the Atlantic Ocean which forms the southern limits of Nigerian Territory. It has abundant land for agricultural, industrial and commercial activities. In line with the rainfall distribution, a wetter south and a drier northern half. Thus, (Fredrick, *et al*., 2006) classified Nigeria into six (6) agro-ecological zones *viz*: (i) the Mangrove forest and Coastal vegetation, (ii) Rainforest zone, (iii) The Derived savannah (vi) Guinea savannah zone (v) the Sudan savannah and (vi) the Sahel savannah.

There are two basic seasons; wet season which lasts from April to October; and the dry season which lasts from November till March. The dry season commences with Harmattan, a dry chilly spell that lasts till February and is associated with lower temperature a dusty and hazy atmosphere brought about by the North-Easterly winds blowing from the Arabian peninsula across the Sahara; the second half of the dry season, February - March, is the hottest period of the year when temperature range from 33 to 38^0 C.

The population of this study comprises all charcoal producers (registered and non-registered) in selected agro-ecological zones of Nigeria.

Multi-stage sampling procedure was used to select respondents from the population of charcoal producers in the selected agro-ecological zones of Nigeria. From the six agro-ecological zones, 50% were purposively selected because they have high potential for charcoal production (Fredrick, 2006). Major charcoal producing communities were identified and purposively selected in each agro-ecological zone respectively. Fifty percent of rural communities in each agro-ecological zone were selected using simple random sampling technique. Thirty percent of the registered charcoal producers (148) were selected from the population of all registered charcoal producers available in each of the selected communities using simple random sampling technique. Snowball technique was used to identify and generate list of non-registered charcoal producers. Thus, 179 non-registered charcoal producers were selected. A total of three hundred and twenty seven charcoal producers in the selected agro-ecological zones were used as respondents for this study.

The general objective is to assess the level of involvement in charcoal production among different agro-ecological zones of Nigeria.

The specific objectives are to: examine the selected socio-economic characteristics of charcoal producers in the study area; determine the methods of CP; and to determine the level of involvement of rural dwellers in different stages of CP in the study area.

Results and discussion

Table 1 indicates that the modal age-range is between 35 and 44 years (45.1%) with a mean age of 44 years. Across agro-ecological zones, the modal ages were within the same age-range of between 35 and 44 years with 35.1%, 49.1% and 48.1% representing rainforest, derived and guinea savannah zones, respectively. This shows that they are in their productive ages. This result is in consonance with the study of Stockholm Environment Institute (SEI) (2002) [10], which reported that CP appears to be dominated by the active age-range of between 35 and 45years.

When discussing livelihood matters, sex is a vital variable. Majority (88.0%) of respondents were males. This may be as a result of the rigour involved in some of the activities of CP. In a related study by CP in South Africa (CHAPOSA) (2002), it was revealed that 70.0% of charcoal producers were males. Majorities (92.0%) of respondents were married. The involvement of many married people in the production of charcoal is in tandem with CHAPOSA (2002) finding that more married people are found in CP. Majority (63.7%) of the respondents had formal education and 26.3% had no formal education. Data across the zones revealed that more respondents (59.0%) in the rainforest zone and 54.1% in derived savannah possessed primary school certificate, while, 30.6% of respondents in the guinea savannah attended Koranic School. Only the derived savannah zone had 3.8% of respondents with National Diploma and higher certificates. This implies that respondents in the derived and forest agro-ecological zones were more educated than those in the guinea savannah zone. Kammen, *et al.* (2005) [6], in contrast with this study, reveals that majority of the people involved in CP in sub-Saharan Africa countries are not formally educated. The inability of charcoal producers to be highly educated may reduce their chances of job mobility.

Considering their primary occupation, 41.0% of respondents were charcoal producers while 34.3% were crop farmers. In the guinea savannah zone, 49.4% were crop farmers and 35.3% were fisher folks with only 14.1% taking CP as their primary occupation. In the rainforest zone, 54.2% of respondents were crop farmers while 68.8% of respondents in the derived zone were charcoal producers. This result shows that respondents in the forest and guinea savannah have crop farming as their primary occupation whereas majority (69.8%) of the people in the derived savannah takes CP as their 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 CP activities because they clear lands which provide easy access to wood for CP. The average year of experience was 13±4.9. The modal class of respondents' years of experience was within the range of 11-15 years (39.8%), while 35.1% of respondents had more than 15 years of experience in CP with (9.8%) of respondents having less than five years of experience in CP activities. Across the agro-ecological zone, the mean years of experience are 11 for the RF vegetation zone, 14 for the derived and guinea savannah zones. About 46.5% of respondents in the derived savannah zone had more than fifteen years of experience in CP, 61.4 percent in the rainforest and 45.8% in the guinea savannah zone had between 11 and 15 years of experience in CP. This implies that the greater the number of years of experiences of respondents the better their performance in CP. In a related study by Bada, *et al.* (2009) [2], it was revealed that the years of experience of charcoal producers in some parts of Nigeria is between 5 and19 years.

Table 1: Socio-economic characteristics of charcoal producers

Socio-economic characteristics	Rainforest zone Age mean=46 Std dev.=9.3		Derived savannah zone Age mean = 44 Std dev = 8.2		Guinea savannah zone Age mean=43 Std dev.=8.0		Total respondents Age mean=44 Std dev.=8.5	
Age (Years)	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
25-34	7	8.4	8	5.0	8	9.5	23	7.0
35-44	29	35.0	78	49.1	41	48.1	148	45.1
45-54	26	31.3	51	32.1	26	30.5	103	31.4
More than54	21	25.3	22	13.8	10	11.9	53	16.5
Total	83	100.0	159	100.0	85	100.0	327	100.0
Sex								
Male	73	88.0	138	86.8	77	90.5	288	88.1
Female	10	12.0	21	13.2	8	9.5	39	11.9
Total	83	100.0	159	100.0	85	100.0	327	100.0
Educational Attainment								
No formal educ.	14	16.9	42	26.4	30	35.3	86	26.3
Koranic school	7	8.4	10	6.3	26	30.0	43	13.2
Pry. School	49	59.0	86	54.1	17	20.6	152	46.5
Secondary s	11	13.3	15	9.4	12	14.1	38	11.6
OND and above	2	2.4	6	3.8	0	0.0	8	2.4
Total	83	100.0	159	100.0	85	100.0	327	100.0
Marital status								
Married	75	90.4	149	93.7	77	90.6	301	92.0
Single	5	6.0	7	4.4	5	5.9	17	5.2
Widow	3	3.6	3	1.9	2	2.3	8	2.4
Divorced	0	0.0	0	0.0	1	1.2	1	0.4
Total	83	100.0	159	100.0	85	100.0	327	100.0
Primary occupation								
Crop farming	45	54.2	25	15.7	42	49.4	112	34.3
Fishing	9	10.8	0	0.0	30	35.3	39	11.9
Charcoal production	11	13.3	111	69.8	12	14.1	134	41.0
Trading	14	16.9	8	5.0	1	1.2	23	7.0
Civil servant	0	0.0	15	9.5	0	0.0	15	4.6
Hunting	4	4.8	0	0.0	0	0.0	4	1.2
Secondary occupation								
Crop farming	10	12.0	101	63.6	14	16.4	125	38.3
Fishing	1	1.2	0	0.0	0	0.0	1	0.3
Charcoal production	68	81.9	49	30.8	70	82.4	187	57.2
Weaving	0	0.0	5	3.1	1	1.2	6	1.8
Hunting	4	4.9	3	1.9	0	0.0	7	2.1
Working as hired labour	0.0	0.0	1	0.6	0	0.0	1	0.3
Years of experience	**Mean = 11**		**Mean=14**		**Mean=14**		**Mean=13**	
	SD=4.3		**SD=5.4**		**SD=4.2**		**SD=4.9**	
less than 5years	9	10.8	17	10.7	6	7.1	32	9.8
6-10years	16	19.4	28	17.6	6	7.1	50	15.3
11-15years	51	61.4	40	25.2	39	45.8	130	39.8
more than15years	7	8.4	74	46.5	34	40.0	115	35.1
Total	83	100.0	159	100.0	85	100.0	327	100.0

2.0 Methods of charcoal production

Table 2 shows that 92.4% of the total respondents made use of earth mound method of charcoal production. Across the agro-ecological zones, RF (100.0%), DS (95.0%) and GS (80.0%) of respondents made use of earth mound method. Only 5.0% and 20.0% of respondents made use of the pit method in the derived and guinea savannah zones respectively. This suggests that earth mound is very

prominent in all the agro-ecological zones. In a related study by Bada, *et al.* (2009) [2], surface (earth mound) method was found to be the most commonly used method of CP in many parts of Nigeria.

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

Methods used in charcoal production	Rainforest zone		Derived savannah		Guinea savannah n=85		Total respondents n=327	
	F	%	F	%	F	%	F	%
Earth mound	83	100.0	151	95.0	68	80.0	302	92.4
Pit method			8	5.0	17	20.0	25	7.6
Total	83	100.0	159	100.0	85	100.0	327	100.0

3.0 Respondents' level of involvement in the stages of charcoal production

According to SEI (2002) the stages of CP are selection of site, felling of trees, cutting of trees into short logs, kiln base structure formation, stocking of logs into kiln, kiln insulation with grass and soil, ignition of kiln, control of carbonation, monitoring of cooling, sorting of charcoal, packing of charcoal into bags, storing of charcoal, transporting charcoal, and marketing of charcoal.

Table 3.1, reveals that in the rainforest zone, 100.0%, of respondents were not involved in the drying of wood, felling of trees (88.0%,), cross cutting of trees into logs (88.0%), and selection of site (48.2%).. This implies that respondents in the RF zone are not actively involved in the felling of trees and in cutting of trees into log.

In Table 3.1, 98.7%, 85.6% and 81.1% of respondents in the DS zone were not involved in wood drying, felling of trees and cross cutting of trees into logs, respectively. However, unlike respondents in the RF, 68.6% of respondents in the DS were involved in selecting kiln site. Most of those that were not involved in new site selection in the RF zone show that they produce charcoal where they fell the wood.

Unlike in the RF zone where few producers are personally involved in marketing of charcoal, majority of respondents in the DS zone usually take part in marketing of charcoal. This implies that most respondents in the DS take charcoal production as their primary occupation.

Table 3.2 reveals that in the GS zone, 68.2% of respondents were involved in the selection of site for charcoal production while, 85.9% of respondents were involved in storing of charcoal, transporting charcoal (80.0%,), ignition of kiln (80.0%,), packing of charcoal into bags (76.5%,), sorting of charcoal (74.1%,), kiln insulation with grass (74.1%) and soil as well as monitoring of cooling (71.8%). While most of the respondents were not involved in the felling of trees and cross cutting of trees into logs, in the rainforest and derived savannah zones, only a few respondents were involved in such activities in the guinea savanna zone.

Table 3.2 reveals that respondents in all agro-ecological zones were actively and physically involved in different stages of CP. These include selection of site for kiln construction (61.5%), kiln base structure formation (79.8%) and marketing of charcoal (70.9%). Barely fifty three percent (52.6%) of the respondents did not dry the wood used for CP. This implies that respondents are involved to a large extent in most of the activities. This is in contrast with the findings of CHAPOSA (2002), which described drying of wood as one of the key activities in which charcoal producers are fully involved during CP.

Table 3: Involvement in the stages of charcoal production

S/N	Involvement in the stages of charcoal production	Rainforest zone						Derived savannah zone					
		Not at all		Occasionally		Always		Not at all		Occasionally		Always	
		F	%	F	%	F	%	F	%	F	%	F	%
1	Selection of site	40	48.2	9	10.8	34	41.0	43	27.0	7	4.4	109	68.6
2	Felling of trees	73	88.0	1	1.2	9	10.8	136	85.5	9	5.7	14	8.8
3	cross cutting of trees into log	73	88.0	1	1.2	9	10.8	129	81.1	10	6.3	20	12.6
4	Drying of wood	83	100.0	0	0.0	0	0.0	157	98.7	0	0.0	2	1.3
5	Kiln base	11	13.3	3	3.6	69	83.1	10	6.3	12	7.9	137	86.2
6	Stocking of logs	13	15.7	1	1.2	69	83.1	15	9.4	14	8.8	130	81.8
7	Kiln insulation with grass	4	4.8	6	7.2	73	88.0	1	0.6	17	10.7	141	88.7
8	Ignition of kiln	9	10.8	4	4.8	70	84.3	8	5.0	13	8.2	138	86.8
9	Control of carbonation	8	9.6	4	4.8	71	85.5	3	1.9	18	11.3	138	86.8
10	Monitoring of Cooling	7	8.4	11	13.3	65	78.3	2	1.3	25	15.7	132	83.0
11	Sorting of charcoal	4	4.8	15	18.1	64	77.1	3	1.9	73	45.9	83	52.2
12	Packing of charcoal into bags	5	6.0	29	22.9	59	77.1	4	2.5	77	48.4	78	49.1
13	Storing of charcoal	2	2.4	9	10.8	72	86.7	2	1.3	15	9.4	142	89.3
14	Transport of charcoal	6	7.2	27	32.5	50	60.2	54	34.0	33	20.8	72	45.3
15	Marketing of charcoal	26	31.3	30	36.1	27	32.5	17	10.7	5	3.1	137	86.2

Table 4: Involvement in the stages of charcoal production

S/N	Involvement in the stages of charcoal production	Guinea savannah zone						Total respondents (327)					
		Not at all		Occasionally		Always		Not at all		Occasionally		Always	
		F	%	F	%	F	%	F	%	F	%	F	%
1	Selection of site	15	17.6	12	14.1	58	68.2	96	30.0	28	8.5	201	61.5
2	Felling of trees	32	37.6	22	25.9	31	36.5	239	73.1	32	9.8	56	17.1
3	cross cutting of trees into log	37	43.5	21	24.7	27	31.8	239	73.1	32	9.8	56	17.1
4	Drying of wood	84	98.8	1	1.2	1	1.2	172	52.6	35	10.7	120	36.7

5	Kiln base	25	29.4	4	4.7	56	65.9	47	14.4	19	5.1	261	79.8
6	Stocking of logs	27	31.8	2	2.4	56	65.9	56	17.1	17	5.2	254	77.7
7	Kiln insulation with grass	9	10.6	13	15.3	63	74.1	14	4.3	36	11.0	277	84.7
8	Ignition of kiln	9	10.6	8	9.4	68	80.0	26	8.0	26	8.0	275	84.1
9	Control of carbonation	15	17.6	10	11.8	60	70.6	26	8.0	33	10.1	268	82.7
10	Monitoring of Cooling	12	14.1	12	14.1	61	71.8	21	6.4	48	14.7	258	78.9
11	Sorting of charcoal	2	2.4	20	23.5	63	74.1	9	2.8	107	32.7	211	64.5
12	Packing of charcoal into bags	2	2.4	18	21.2	65	76.5	11	3.4	113	34.6	203	62.1
13	Storing of charcoal	7	8.2	5	5.9	73	85.9	11	3.4	29	8.9	287	87.8
14	Transport of charcoal	11	12.9	6	7.1	68	80.0	72	2.0	26	19.9	190	58.1
15	Marketing of charcoal	17	20.0	1	1.2	67	78.8	60	18.3	35	10.7	232	70.9

3.3 Level of involvement in the stages of charcoal production across zones

Table 3.3 reveals that 50.8% of respondents had high level of involvement in the stages of CP. Across the agro-ecological zones, 51.6% in DS and 60.0% in GS had high level of involvement in the stages of CP while only 39.8percent of respondents in the RF zone had high level of involvement in the stages of CP. All the agro-ecological zones showed almost the same percentages in low level of involvement in CP as recorded by RF (36.1%), DS (31.4%) and GS (31.8%) of respondents.

The high level of involvement implies that charcoal producers are actively involved in almost all the stages of CP. Shackleton, *et al.* (2006) [8] noted that CP is a very profitable business. Although the use of external hands is encouraged, some of the activities need personal involvement for a better output.

Table 5: Level of involvement in the stages of charcoal production

Agro-ecological zones		Rainforest n=83		Derived savannah n=159		Guinea savannah n=85		Total respondents n=327	
Involvement in charcoal production	Scores	Mean score=19.04 Std. dev.=0.87		Mean score=18.20 Std. dev.=0.89		Mean score=20.28 Std. dev.=0.92		Over all mean score=20.18 Std. dev.=0.89	
		Freq	%	Freq	%	Freq	%	Freq	%
Low	4-19.28	30	36.1	50	31.4	27	31.8	107	32.7
Medium	19.29-20.2	20	24.1	27	17.0	7	8.2	54	16.5
High	20.3-30.0	33	39.8	82	51.6	51	60.0	166	50.8

3.4 Significant difference in respondents' level of involvement in different stages of charcoal production across the agro-ecological zones

Result of analysis of variance on Tables 3.4 reveals that there was a significant difference in respondents' level of involvement in the various stages of CP across the agro-ecological zones (F = 34.848). This implies that respondents in each agro-ecological zone have different levels of involvement in the stages of CP. Duncan's multiple range analysis revealed that respondents in the GS are more physically involved in different stages of CP with a mean of 24.1_{b}, while those in the rainforest and DS zones have the same level of involvement in different stages of CP. This may be as a result of different financial state of each producer as well as availability of different sources of human resources to assist in the production of charcoal. While charcoal producers in the GS personally use manual implements to carry out the operations, those in the RF and DS make use of hired labourers in some of the activities. SEI (2002) corroborated this claim that involvement in the stages of charcoal production are functions of the primary occupation of charcoal producers, availability of labour and the quest to produce high quality charcoal.

Table 6: Differences in the respondents' level of involvement in the different stages of charcoal production across the agro-ecological zones

Parameter	Statistical tool	Df	Sum of square	Mean square	F value	p value	Decision
Involvement in the different stages of charcoal production	Analysis of variance	2	982.138	491.069	34.848	0.00	Significant

Duncan's Multiple Range Test
Mean N Vegetation
20.6_{a} 159 Derived savannah
19.5_{a} 83 Rainforest
24.1_{b} 85 Guinea savannah
Letters that are the same are not significantly different

Conclusion

The study shows that charcoal producers were males who in their productive ages. Almost half of them had CP as their primary occupation with more than a decade years of experience in CP. Across the agro-ecological zones, respondents from GS had high level of involvement in the stages of CP followed by DS and the RF zones respectively.

Recommendations: Since involvement in charcoal production is a function of degree of poverty, other livelihood activities such as horticulture, fisheries, bee keeping, and snailery that could reduce their involvement in CP should be encouraged.

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