



Assessment of Charcoal Production and Its Impact on Deforestation and Environment in Borgu Local Government Area of Niger State, Nigeria

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ABSTRACT: Commercial charcoal production is gradually becoming one of the major sources of sustenance and currently plays a major role in promoting entrepreneurial development in Borgu Local Government Area of Niger State. The study was carried out to assess charcoal production and its impact on deforestation and environment in the study area. Data for the study were generated from a structured questionnaire administered to charcoal producers in the study area. Data obtained revealed that majority (83%) were male with 56% within the age class of 21-40, majority (67%) were married and about (51%) attained primary education. Majority of the producers (82%) used traditional earth mound kiln method for charcoal production and about 56% of the producers obtained their raw material from free area. Most preferred tree species for charcoal production was *Prosopis africana* and accounted for 61%. Loss of biodiversity ranked 1st as regards impact of charcoal production on deforestation and environment in the study area, closely followed by forest degradation and soil degradation respectively. This study will enable forestry policy makers, charcoal producers, and farmers in the study area to be better informed about the implications of charcoal production on deforestation and environment and seek innovative means and ways to combat its menace.

DOI: <https://dx.doi.org/10.4314/jasem.v26i4.22>

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Google Analytics: <https://www.ajol.info/stats/bdf07303d34706088ffffbc8a92c9c1491b12470>

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Dates: Received: 09 March 2022; Revised: 13 April 2022; Accepted: 27 April 2022

Keywords: deforestation, charcoal, biodiversity, environment, woodland

Charcoal is a solid residue consisting mainly of carbon obtained by the destructive distillation of wood in the absence of air (UN-DESA, 2019). Charcoal is a cheap source of energy for both rural and urban dwellers (Eniola, 2021). It serves as a source of employment for a number of rural inhabitants (Arnold *et al.*, 2006) due to its quick return on investment (Stefan, 2009). However, in spite of its numerous benefits, charcoal production has its adverse effects such as desertification, environmental degradation, global warming and climate change, these are all linked to deforestation. Deforestation is a product of charcoal production which has significant impacts on the environment, especially with regard to increased erosion. It can also worsen climate change and threaten biodiversity. Deforestation is the destruction of forest areas for several purposes, such as agriculture, urbanization, and wood fuel and charcoal production. Charcoal production requires commercial

falling of trees which leads to deforestation (Eniola, 2014; Eniola, 2021). Some important tree species such as shea butter tree and mahogany which were abundant in the past are now becoming scarce as a result of live cutting for charcoal production (Pabi and Morgan, 2002).

Therefore, the study was conducted to assess charcoal production and its impact on deforestation in Borgu Local Government area of Niger State, Nigeria.

MATERIALS AND METHOD

Study Area: This study was carried out in Borgu Local Government Area of Niger State, Nigeria. It is one of the 25 Local Government Areas in the state with the headquarters in the town of New Bussa (Figure 1). The Local Government has a population of 242, 800 according to Niger State projected population census

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2016. It is located between Latitudes $9^{\circ}55'11.2''N$ to $9^{\circ}89'55''N$ and longitudes $4^{\circ}30'37''E$ to $4^{\circ}49'39''E$. The Local Government is bounded to the East by the River Niger/Kainji Lake and Magawa Local Government Area, Kebbi State in the Northern part, Kwara State and Benin Republic in the West (Ibrahim *et al.*, 2020). The main occupation of the people in the study area is farming; crop farming, fish farming and livestock rearing are the major types of farming practiced. The vegetation of the study area is southern guinea savannah and is characterized by tall grasses and shrubs, with trees of mean total height between 6m and 15m. Few examples of tree species in the study area include *Pterocarpus erinaceus*, *Anogeissus leiocarpus*, *Vitellaria paradoxa*, *Lannea acida*, *Lannea schimperi*, *Azelia africana*, *Burkea africana* and *Terminalia glaucoscens* (Adeniji *et al.*, 2021). Six villages; Yangba, Gada-Oli, Karabonde, Luma, Tamanai and Tunga-Boka, where charcoal production is prevalent were purposively selected for the study.



Fig 1: Map of Borgu Local Government Area, Niger State, Nigeria. (Source: Adeniji *et al.*, 2021)

Sampling Techniques and Data Analysis: The data for this study were generated from a structured questionnaire administered to the respondents (charcoal producers) in the study area. Non probability sampling method (purposive and snowball sampling) was used for the study. In addition, interviews and personal observation were also used to obtain information in the study area. Six villages; Yangba, Gada-Oli, Karabonde, Luma, Tamanai and Tunga-Boka, were purposively selected for the study for two reasons, first, due to large scale production of charcoal in those villages, and secondly, due to their proximity to New Bussa town as a result of insecurity in Niger

State. Charcoal producers were then selected using snowball technique in each of the villages, with this method, the first charcoal producer identified helps locate the next producer till all charcoal producers were reached and administered the copies of questionnaire in each of the villages. The breakdown of the respondents sampled in each of the villages are as follows: Yangba (14), Gada-Oli (17), Karabonde (12), Luma (20), Tamanai (15) and Tunga-Boka (13). A total of 91 copies of questionnaire were administered to charcoal producers in the study area with 87 copies retrieved. The data collected included the socio-economic characteristics of charcoal producers (age of respondents, sex, educational status, marital status), others are method of charcoal production, sources of raw materials for charcoal production, impact of charcoal production on deforestation, tree species used for charcoal production etc. Data were coded using Microsoft Office Excel 2013 and analyzed using descriptive statistics on SPSS 20.0 software version and the results were presented using tables and chart.

RESULTS AND DISCUSSION

The results in Table 1 showed the socio-economic characteristics of the 87 respondents involved in charcoal production in the study area. It revealed that majority (83%) of the respondents were male, while female made up 17% of the charcoal producers. Only 7% of the respondents were within 0-20 years, while 17% were within the age class of 21-30 years. About 39% were within 31-40 years while 29% were within the age group of 41-50 years and only 8% were within 50 years and above. Majority of the respondents (67%) were married while 18% were single, 9% were widowed while 6% were separated. About 18% had no formal education, 51% of the respondents attained primary school education, while 29% attained secondary education and only 2% attained tertiary education. As regards occupation of the respondents in the study area, Majority of the respondents (71%) were farmers, 21% traders, 5% civil servants and other respondents had only 3%. The results in Figure 1 showed method of charcoal production in the study area, it revealed that majority of the charcoal producers (82%) used earth mound kiln, while only 18% of the charcoal producers used earth pit kiln method for charcoal production. The result in Table 2 showed sources of tree species for charcoal production in the study area. Majority (56%) of the charcoal producers obtained their raw material from free area, about 30% of the respondents got their wood from farmland, and only 6% and 8% of the charcoal producers sourced for trees for charcoal production from protected woodland and woodlots respectively.

Table 1: Characteristics of the respondents in the study area

Demography	Category	F	%
Sex	Male	72	83
	Female	15	17
	Total	87	100
Age (Years)	0-20	6	7
	21-30	15	17
	31-40	34	39
	41-50	25	29
	50 and above	7	8
	Total	87	100
Marital Status	Single	16	18
	Married	58	67
	Widowed	08	09
	Separated	05	06
	Total	87	100
Education	No Formal Education	16	18
	Primary Education	44	51
	Secondary education	25	29
	Tertiary Education	02	02
Total	87	100	
Occupation	Farming	62	71
	Trader	18	21
	Civil Servants	04	05
	Others	03	03
	Total	87	100

Source: Field Survey, 2021; F = Frequency; % = Percentage

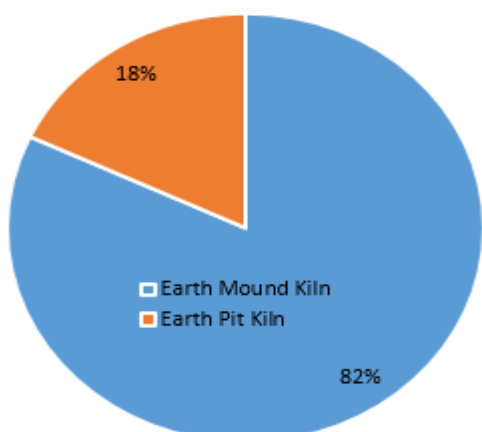


Fig 2: Method of Charcoal Production
Source: Field Survey, 2021

The list of tree species commonly used for charcoal production in the study area are presented in Table 3, the family, scientific and common names are provided. The result in Table 4 showed preferred tree species used for charcoal production in the study area, *Prosopis africana* was listed as the most preferred tree species with 61% followed by *Anogeissus leiocarpus* with 24%, *Pericopsis laxiflora* had 8%, *Burkea africana* had 5% while *Vitellaria paradoxa* had the least with 2%. The result in Table 5 revealed the impact of charcoal production on deforestation and environment in the study area. Majority of the charcoal producers (98%) chose loss of biodiversity as the leading impact of charcoal production on deforestation and environment and ranked 1st, closely followed by forest degradation with 91% and ranked 2nd. Soil

degradation occupied 3rd position with 83%, increased desertification ranked 4th with 77%.

Table 2: Sources of wood for charcoal production

Source	Frequency	Percentage
Farmland	26	30
Free area	49	56
Protected woodland	5	6
Woodlots	7	8
Total	87	100

Source: Field Survey, 2021

Table 3: List of tree species used for charcoal production in the study area

Family	Scientific Name	Common Name
Fabaceae	<i>Prosopis africana</i>	Iron wood
Combretaceae	<i>Anogeissus leiocarpus</i>	African birch
Caesalpiniaceae	<i>Burkea africana</i>	Wild syringa
Fabaceae	<i>Pterocarpus erinaceus</i>	Kosso
Fabaceae	<i>Azelia africana</i>	Apa
Sapotaceae	<i>Vitellaria paradoxa</i>	Shea tree
Fabaceae	<i>Isobertinia doka</i>	Doka
Fabaceae	<i>Daniellia oliveri</i>	Copal tree
Fabaceae	<i>Pericopsis laxiflora</i>	Satin wood
Combretaceae	<i>Terminalia glaucescens</i>	Terminalia
Combretaceae	<i>Terminalia macroptera</i>	Terminalia
Lamiaceae	<i>Tectona grandis</i>	Teak
Lamiaceae	<i>Gmelina arborea</i>	Gmelina
Anacardiaceae	<i>Mangifera indica</i>	Mango

Source: Field Survey, 2021

Air pollution and increased temperature ranked 5th and 6th respectively. The result in Table 6 showed respondents' effort in mitigating the impact of charcoal production on deforestation and environment. The question was in open ended form. Majority (77%) of the respondents responded with "no effort" while 23% believed "natural regeneration will take place with time". Male constituted the majority (83%) of the charcoal producers in the study area, the reason for this is due to the fact that males engage in jobs that involve physical strength such as farming, charcoal production etc than females. This is in agreement with Adeniji *et al.* (2015) in their study titled charcoal production and producers' tree species preference in Borgu Local Government Area of Niger State, where 91% of the charcoal producers in the study area were males. It is also in agreement with the findings of Ekhuemelo *et al.* (2019) in their study titled evaluation of charcoal production in Makurdi and Guma Local Government Areas of Benue State, where 85% of the respondents were males. As regards age of the respondents, the study revealed that most of the respondents were between the productive ages of 21-50 years representing 85% in total. This is very close to what was obtained by Ekhuemelo *et al.* (2019), who revealed that 87% of the respondents in Makurdi and Guma Local Government Areas of Benue State were between the productive ages of 21-50 years.

Table 4: Preferred tree species used for charcoal production in the study area

Scientific Name	Common Name	Frequency	Percentage
<i>Prosopis africana</i>	Iron wood	53	61
<i>Anogeissus leiocarpus</i>	African birch	21	24
<i>Pericopsis laxiflora</i>	Satin wood	7	8
<i>Burkea africana</i>	Wild syringe	4	5
<i>Vitellaria paradoxa</i>	Wild syringe	2	2
Total		87	100

Source: Field Survey, 2021

Table 5: Impact of charcoal production on deforestation and environment in the study area

Impact	Frequency	Percentage	Ranking
Increased desertification	67	77	4 th
Loss of biodiversity	85	98	1 st
Soil degradation	72	83	3 rd
Forest degradation	79	91	2 nd
Air pollution	53	61	5 th
Increased temperature	37	43	6 th
Others	15	17	7 th

Source: Field Survey, 2021; *Multiple response

Table 6: Effort in mitigating the impact of charcoal production on deforestation and environment

Effort	Frequency	Percentage
No effort	67	77
Believes regeneration will take place with time	20	23
Total	87	100

Source: Field Survey, 2021

In terms of marital status, Majority (67%) of the respondents were married, the high profit margin in charcoal business may have been the motivational factor sustaining their households for years. This is also close to the findings of Adeniji *et al.* (2015) in their study titled charcoal production and producers' tree species preference in Borgu Local Government Area of Niger State, where 73% of the charcoal producers in the study area were married. In terms of education, about half (51%) completed primary education, while about 29% had secondary education, about 18% had no formal education, while only 2% completed tertiary education. The high percentage (80%) of the respondents who attained both primary and secondary school education may be said to have contributed to the increase in deforestation as a result of charcoal production in the study area, this is possible due to the low level of education attained by the majority of the respondents, as such adequate knowledge about benefits of forests may be lacking. Majority (71%) of the respondents are farmers, this is understandable as the farmers in the study area engage in charcoal production during dry season when there is no rain for crop cultivation, this agrees with Tunde *et al.* (2013) in their study titled impact of charcoal production on the sustainable development of Asa Local Governemnt Area, Kwara State, where 75% of the respondents were farmers. Traditional earth kiln is the most widely used method of charcoal production in Sub-Saharan Africa, Nigeria inclusive (Chidumayo & Gumbo, 2013; Brobbey *et al.*, 2015; Chiteculo *et al.*, 2018). Obiri *et al.* (2014) describe its features and

use which includes, stacking wood, covering it up with fresh leaves, and then covering it up with dug up soil before the carbonization which can take up to few days. In the study area, majority (82%) of the charcoal producers used traditional earth mound kiln which agrees with above literatures. Most (56%) of the trees for charcoal production in the study area are sourced from free areas, free areas are forest land or woodland that are not under strict forestry regulation. As a result of easy access into the woodland without strict resistance, the charcoal producers go into the woodland and cut down trees for charcoal production. This is in line with Tee *et al.* (2009) who reported that 62% of the fuel wood gatherers in their study area source for trees from free forest area.

The list of tree species for charcoal production in the study area include *Prosopis africana*, *Anogeissus leiocarpus*, *Pericopsis laxiflora*, *Vitellaria paradoxa*, *Azalia africana*, *Burkia africana*, *Pterocarpus erinaceus* amongst others. Most charcoal producers in the study area use trees and shrubs that are readily available in their vicinity. However, not all tree species are used in equal measure. Blay *et al.* (2007) found that trees such as *Azadirachta indica*, *Mangifera indica* and *Parkia biglobosa* are sparingly used because of their high economic or medicinal value. Brobbey *et al.* (2015) found that in some cases, customary regulation prohibited their use entirely for charcoal production. Most of the trees listed here are also listed as tree species for charcoal production in savannah woodland of Nigeria and Sub-Saharan

Africa (Obiri *et al.*, 2014; Brobbey *et al.*, 2015; Adeniji *et al.*, 2015; Ekhuemelo *et al.*, 2017; Adebayo *et al.*, 2019; Ekhuemelo *et al.*, 2019; Kumeh *et al.*, 2020 and Ekpo *et al.*, 2021). *Prosopis africana* was listed as the most preferred choice of species for charcoal production in the study area as revealed in Table 4. One of the reasons for this is the quality of charcoal produced from this specie, the resultant charcoal burns slowly and last longer, in addition, the tree is readily available in the study area (Ekpo *et al.*, 2021). However, this finding is in agreement with Adeniji *et al.* (2015); Ekhuemelo *et al.* (2019) and Ekpo *et al.* (2021) who all found that *Prosopis africana* was the most preferred tree species for charcoal production in their studies.

Charcoal production in Nigeria result in different forms of problems some of which are environmental pollution arising from smoke, deforestation as a result of tree harvest and erosion which exposes the soil to direct sunshine, it also leads to reduction in the soil fertility and health problems to people around the production site (Ajadi *et al.*, 2012; Rotowa *et al.*, 2019).

The leading impact of charcoal production on deforestation and environment in the study area is loss of biodiversity (98%). The production of charcoal has led to massive destruction of woodland trees and shrubs and this has threatened some animals in the study area. Trees and shrubs are cut indiscriminately without replanting, some of the charcoal producers use power saw in felling trees for charcoal production and the noise generated scare away wild animals and cause them to migrate to other places. According to Chidumayo and Gumbo (2013) and Kiruki *et al.* (2017), Charcoal production has been found to hinder regeneration as well as altering species composition which directly lead to loss of biodiversity. In addition, gathering of leaves and grasses is another process of charcoal production that removes leaves of plants and also have negative impact on grass vegetation. Another impact of charcoal production in the study area according to charcoal producers is forest degradation; this occurs when forest ecosystems lose their capacity to provide important goods and services to people and nature. In the course of charcoal production, trees and shrubs are cut down without replacement, leaving few trees or less species of trees, and few animals, which makes the forest or woodland less valuable. Charcoal production in the study area has contributed to forest degradation through loss of biodiversity including animals, poor soil quality and low agricultural production (Nyarko *et al.*, 2021). In addition, some economic tree species such as *Vitellaria paradoxa*, *Parkia biglobosa*, *Mangifera*

indica amongst others that are source of food and fruits are sometimes cut and used for charcoal production in the study area, which also leads to degradation of the woodland, this agrees with Nabukalu and Giere (2019) where some economic trees species which are sources of food are cut for charcoal production. Soil degradation is another impact revealed by the charcoal producers in the study area, when trees are cut for charcoal production, the land becomes susceptible to erosion, and structure of the soil is also destroyed. Charcoal production also affect the soil structure in two ways, first it impacts the soil on the earth mound kiln site where combustion takes place as a result of huge heat that is released from the covering process and second, it affects the structure of the surrounding soil of the production site (Eniola, 2021). The soil in the site of charcoal production has a slight increase in pH and higher infiltration rate compared to surface not subjected to charcoal production (Ogundele *et al.*, 2011). Other impact of charcoal production in the study area are increased deforestation, air pollution and increase in temperature.

Majority of the respondents revealed there was no effort in mitigating the impact of charcoal production on deforestation and environment. According to respondents interviewed, they believed the impact was minimal and would not really affect them in anyway, hence they were not making any efforts in mitigating the impacts. A few number of the respondents believed natural regeneration of trees would take place and the impact would disappear with time. One of the interviewers believed during raining season when there is little or no activity of charcoal production, the woodland would regenerate by itself which would cushion the impact from charcoal production.

Conclusion: The result of this study showed that the leading impact of charcoal production on deforestation and environment is loss of biodiversity, others include; soil and forest degradation, increased desertification and air pollution. This study will enable forestry policy makers and charcoal producers to be better informed about the implications of charcoal production on deforestation and environment and seek innovative ways to combat its menace. However, Government should enforce tree planting policies since it could be difficult to stop felling of trees for charcoal production as a result of existing poverty problem in rural areas.

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