Bima Journal of Science and Technology, Vol. 7 (2) June, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.410

# ENVIRONMENTAL IMPLICATIONS OF CHARCOAL PRODUCTION IN AKKO LOCAL GOVERNMENT AREA GOMBE STATE, NIGERIA

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## ABSTRACT

The aim of this study was to examine the environmental implication of charcoal production in Akko Local Government area of Gombe State. The specific objectives was to determine the conversion efficiency of the production techniques used in the study and the environmental consequences of charcoal production. Both qualitative and quantitative data were obtained in the study. Purposive sampling technique was used to select 160 respondents from 16 villages sampled. The instruments used for data collection included direct observation method and key informant interview (KII) The results of data analyzed revealed that the mean conversion efficiency 18.8 and the percentage waste was 81.2 respectively. Five tree species are commonly used in the production of charcoal in the study area. It was found that 5.6 kg of wood would be carbonized to produce one kilogram (1kg) of charcoal. Environmental implications of charcoal production included loss of woodland, grazing land, emergence of gullies, loss of soil nutrient, biodiversity depletion among others. Furthermore, charcoal production in the study area was dominated by men, a situation that was traceable to sociocultural factors like religious. Interaction with charcoal producers and transporters indicated that charcoal production which started over a century has been on the increase. Stakeholders (union leader both in producers and sellers, community leaders and forestry workers) in charcoal business expressed worries about decline in the density of trees with the negative environmental consequences. It has been recommended that in order to halt the reckless felling of trees and the attendant environmental degradation, urgent interventions are required from government and non-governmental organizations to find alternative sources of domestic energy.

**Keywords:** Environment, Production, Charcoal, Fuel wood and Akko

## INTRODUCTION

Fuel wood, charcoal in particular, are the main source of energy for cooking in most urban and rural areas of African countries. Urbanization and population growth are the major driving forces that increase the demand for charcoal, which has a negative impact on the forest resource. Given the increasing demand for charcoal, and decreasing availability of biomass, policies are needed to ensure secure energy supplies for urban households and reduce deforestation (Food and Agricultural Organization (FAO) (2017). FAO (2017) estimated that 50 percent of the wood extracted from forest world wide is used as Fuel woods and charcoal. Charcoal production in particular, has been rising in recent decades as demand has grown among urban population and enterprises particularly in Sub Saharan Africa (SSA) but also in South East Asia and South America (FAO, 2017). Charcoal production is expected to grow in SSA in coming decades, especially given that the percentage of Africans living in urban areas is projected to grow from 36 percent in

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2010 to 50 percent by 2030 (World Bank 2014). IEA, (2010) predicted that the number of people in SSA relying on traditional uses of biomass for energy would increase to 918 million by 2030. Thus charcoal demand in Africa is expected to grow at a higher rate than fuelwood demand, almost doubling by 2030 compared to 2010, with a projected annual growth of Three percent (FAO, 2017).

Oriola and Omofoyewa, (2013), reported that in Oyo State, about 40 containers of charcoal are sold per month at the rate of 450,000 Naira per container. The study also reported that Britain currently imports 60,000 tonnes of charcoal every year. To meet this demand over 11,000 tonnes was estimated to be exported in a year by one exporter in a community in Oyo state, where up to 400 trees ware cutted down on a daily basis for the purpose of charcoal production. Large scale charcoal production, primarily in SSA has been a growing concern due to its threat of deforestation, soil degradation and climate change impacts. It is cited by International Energy Agency (IEA) (2010) as the most environmentally devastating phase of this traditional energy supply chain. The traditional charcoal production was also reported to have conversion efficiency and the expected output is generally not found due to poor technology (IEA, 2010).

The yield of carbonization ranged between 10 to 18 percent by weight and 20 to 25 percent by volume (Schure, *et al*. (2013); Fontodji et al, 2011). Despite the role charcoal plays as energy and source of income, the production of charcoal has been associated with environmental degradation through the losses in trees stock and soil nutrients (Fontodji et al, 2011). Chidumayo and Gumbo (2013), estimated that charcoal production was responsible for the losses of 39,000 hectares of vegetated forest due to deforestation in Central America in 2009, 240,000 hectares in South America, 510,000 hectares in Asia and 2,976,000 hectares in Africa. Based on these estimates, Africa account for nearly 80 percent of the charcoal-based deforestation of the world tropical regions. In addition burning also result in plants stock depression and biodiversity loss (Parker, Osei, Armah, and Yawson,. 2010). Studies also reported that soil characteristics such as microbial and soil nutrient quality, especially at kiln sites are significantly affected by charcoal production (Fontodji *et al,* 2011). The impact of charcoal production on biological properties of soil in woodland savanna can be traced to the heat generation during production which affects soil microbial activities and soil organic matter. Thus, it is important examine the cumulative effects of charcoal production on soil properties particularly those that enhance its fertility, since more than 70 percent of the people living in this ecological zone are farmers hence are depend on soil and vegetation for livelihood.

It has was observed that there is an increase in charcoal production in some local governments of Gombe State using traditional earth mound methods. This development may have a negative impact on the environment which necessitates research to uncover the negative effect and prosper a sustainable solution to this menace.

**Study Area**

The study was conducted in Akko local government area, of Gombe state, (Figure 1). Located between latitude 10º 17' 00”.1"N longitude 10º 58' 00". The study area covers a land area of about 2,627 km$^2$. The projection was based on the NPC population census 2006. The study area is characterized by wet and dry seasons largely determined by the properties and movement of the Inter tropical convergence zone (ITCZ). In relation to the koppen's climatic classification the study area is almost entirely within AW types of climate. It is seasonally wet from April to October and dries from October to March. Rainfall ranges from 850 mm to 1000 mm; the rainfall concentration reaches its maximum in July/August. Much of the rainfall especially in July and August are associated with storms of high intensity (Bello, 2015).

The study area is on the complex geologic crystalline bedrocks. Although the ancient crystalline basement complex sedimentary rocks underlie much of the area, the complex is formed during the late cretaceous period, which has influenced the topography of the area (Bello, 2015).

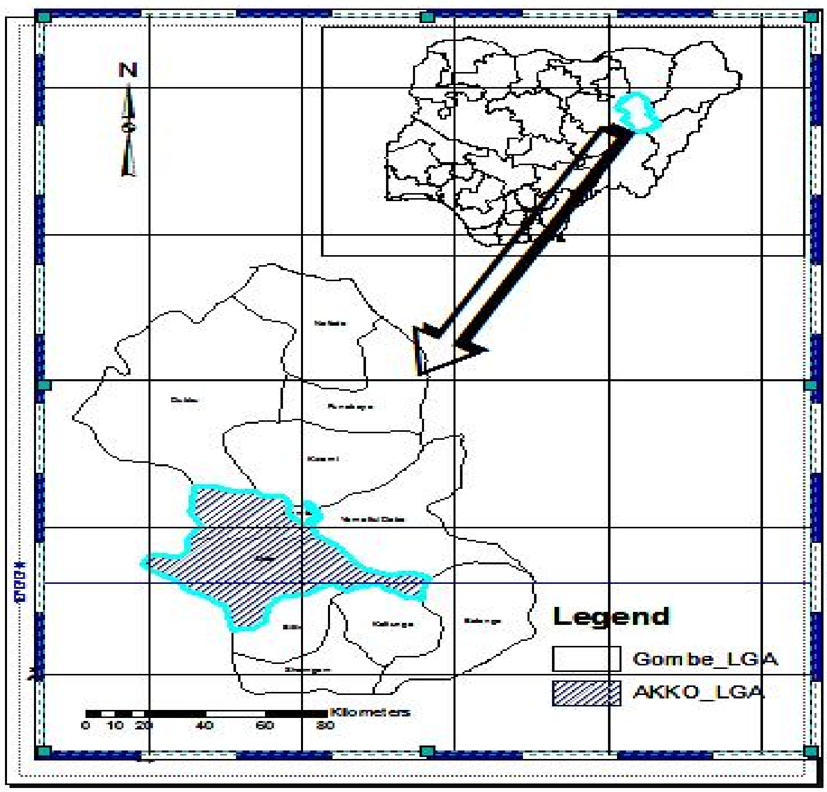


**Figure 1:** Gombe state showing Akko Local Government

The soil is intensively formed as a result of incomplete weathering activities of the basement complex rock. Traditional management practices such as bush clearing, annual burning and livestock grazing have made the soil in the study area susceptible to erosion and reduce its water holding capacity. The vegetation consisted of sparse canopy with spindling of under shrubs and sparse growth of grasses to more open grasses of less height (Bello, 2015). Major trees species in the area include *Anogeissus Leicapus* (Marke), *Burkia Africana* (Kolo), *Prosopis Africana* (Kirya), *Precapsis lexiflora* (Makarho) and *Azadirachta indica (Neem).butyrosper, Mumparadoxum. Tamarine indica, parkia boglobossa, balanite agifika, afzelia Africana, fabia, albida* among others, on the other hand the community are made up of different tribes which include Fulani, Hausa, Bolewa, Kanuri, Tangale, Kamo, Jukun, Karkare, Jukun, Yoruba, and Igbo. In addition, all these

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various languages, the Hausa language serves as a lingua-franca in the course of daily interaction among peoples. English language remains the official language as obtained in all parts of the country (Abbas 2012). Their main economic activities is Agriculture which include cultivation of different types of crops such as maize, beans, soya beans, guinea corn groundnut, rice, millet and sorghum and rearing of animals.

## MATERIALS AND METHODS

Data for this study was obtained through primary and secondary data sources. The primary data was collection through Key Informant interview (KII) using semi-structured interview schedules with the charcoal producers. Direct observation methods were used to observed the method of charcoal production techniques in the field, this include cutting down of trees, resizing the logs, making kiln as well as environmental consequences in the area. The secondary data was obtained from online journals and text books to develop literature on the subject matter (charcoal production).

The study population comprised some selected charcoal production communities identified in the study area. 16 villages were selected out of 40 villages identified during reconnaissance surveys in Akko LGA where charcoal production activities are so intense. 16 villages were selected randomly using a balloting method which is 40% of the study area. Ten respondents (charcoal producers) were purposely selected from each village to come up with a total of 160 respondents. Purposive sampling technique was adopted to ensure that only those who have knowledge on the subject matter are contacted.

Direct method of wood weight/volume determination (biomass) was used to determine the conversion efficiency and waste percentages. Direct method was used to determine the relationship between kiln inputs and outputs and to determine kiln efficiency and conversion rates (percentage waste).

Wood volume, percentage waste and conversion efficiency were determined by Newton's formula as thus; V=n$h$24x (Db2+4Dm2+Dt2)

Where $Db^2$ = diameter at the base

$4Db^2$ = diameter at the middle

$Dt^2$ = diameter at the top

Percentage of waste (% waste) = initial weight−charcoal weight x100

## RESULTS AND DISCUSSIONS

Direct method was used to determine conversion efficiency and amount of waste resulting from the process of conversion from wood to charcoal. Five most common used tree species for charcoal production in the study area that is *Anogeissus Leicapus* (Marke), *Burkia Africana* (Kolo), *Prosopis Africana* (Kirya), *Precapsis lexiflora* (Makarho) and *Azadirachta indica (Neem)*. The study revealed that the five tree species have different conversion efficiency using the traditional earth-mound of charcoal production. The study discovered that from the five tree species used in charcoal production *Prosopis Africana* (Kirya) recorded the highest conversion efficiency of 22.8% followed by *Azadirachta indica (Neem)* which recorded 20.4% conversion efficiency. The two species were followed by *Anogeissus Leicapus* (Marke) with 19.7%, the fourth one is *Precapsis lexiflora* (Makarho) with 17.2% and the last one is *Burkia Africana* (Kolo) with conversion efficiency of 14.1 percent (Table 1). The study shows that the average conversion efficiency of all the five tree species was 18.8 % only (Table 1).

The carbonation efficiency of the earth-mound technique of charcoal production used in the study area was low and demonstrated the efficiency of the traditional method of production and its result in large amounts of waste, more than 80% of the initial wood weight. However, the conversion efficiency was higher than the 14.5% and 17.6% as reported by Schure, et al. (2013) in Licuati District and Chikale respectively in Mozambique. The findings are in harmony with World Bank (2011) studies in Kenya and Uganda on traditional charcoal kilns production efficiency, where the average wood-to-charcoal conversion efficiency was found to be 15% and 16% respectively.

Table 1 indicated that when 1412 kg of different tree species was carbonized only 254 kg of charcoal would be realized as output after conversion. Thus each one kilogram (1kg) of charcoal produced is engulfed 5.6kg of wood (1412/254=5.6). At least 247.5 kg of wood is required to produce ± 45kg (one bag) of charcoal. In addition, according to the above computation, about 280800 kg of charcoal are produced by 160 respondents monthly and a total of 1,544,400 (1544 tonnes) of wood equivalent would be carbonized. The annual production of these 16 respondents is about 3,369,600kg (280800x12) of charcoal which can be obtained from 18,533 tonnes of wood or 18,532,800 kg. This would pose serious danger to the already devastated savanna woodland in the study area.

**Table 1:** Trees Species Conversion Efficiency

| Tree Specie | Duration (in Hrs) | No.of log | W.W(kg) | C. W(kg) | C.E(%) | % waste |
|---|---|---|---|---|---|---|
| *Anogeissus Leicapus* (Marke), | 120 | 11 | 239 | 47 | 19.7 | 80.3 |
| *Burkia Africana* (Kolo), | 120 | 11 | 439 | 62 | 14.1 | 85.9 |
| *Prosopis Africana* (Kirya), | 120 | 15 | 228 | 52 | 22.8 | 77.2 |
| *Precapsis lexiflora* (Makarho) | 120 | 10 | 320 | 55 | 17.2 | 82.8 |
| *Azadirachta indica (Neem)* | 120 | 11 | 186 | 38 | 20.4 | 79.6 |
| **Total** | | **58** | **1412** | **254** | **94.1** | **405.8** |
| Mean efficiency & % waste | | | | | **18.8** | **81.2** |

Source: Field work 2020

NB. W. W= wood weight, C. W= charcoal weight, C. E= conversion efficiency

**Environmental Implication of Charcoal Production in the Study Area**

Kiln efficiency is one of the most important factors in the sustainability of charcoal production and its impact on the forest resources. The production technique used in the study area required large quantities of wood input by the charcoal producers for smaller output and by implication large numbers of woody plants were destroyed in the process which had a serious effect on the environment. The study discovered that the rate of tree stock exploitation does not allow natural regeneration of forest to meet up with the rate of extraction, which poses danger to the remaining savanna parkland in the area. Other negative implications of charcoal production in the study area includes; loss of vegetation cover including economic trees, soil erosion resulting from loss of plants cover, decrease in soil nutrient due to leaching and low rainfall due to low evapotranspiration. It is discovered that in the long run such changes in the nature of land cover may result in frequency of drought occurrence, and

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famine. Furthermore, it reduces range land for livestock production, biodiversity extinction, emergence of gullies and land degradation. This issue persists, it would increase the pastoralist vulnerability to drought and famine due to insufficient grazing land and can result in farmers-herders conflicts which can be witnessed in many parts of the country.

The current trend of charcoal production in the study area (33696 tonnes annually) should be a source of concern because the majority of people living in this ecological area are peasant farmers and animal herders who depend on natural capital for their livelihood. The result of this findings are in concomitant with Fosu-Mensah (2012) in Ghana, Schure, et al. (2013), in Mozambique, Ndegwe, (2016) in Kenya who discovered that charcoal production lead to decrease in forest resources and can cause conflicts between farmers and herders. In their separate studies, they all concluded that traditional method charcoal production in many countries across Africa have low conversion efficiency.

Soil living organisms are an important component of the environment affected by charcoal production. The study discovered that the soil and its biodiversity are affected by fire during the carbonization process which has negative implications for soil microbial activity which may lead to concurrent decrease in soil functioning such as decrease in soil organic carbon and decrease in soil moisture content through burning. This findings are in harmony with several studies in Africa (Adeniyi, 2010; Fontodji, et al. 2011; Ogundele, Elodoyin and Oladapo, 2011) on the impact of burning resulting from tradition charcoal production on the soil microbial loads in savanna and tropical rain forest

## CONCLUSION

In Gombe State, as in the rest of towns in Nigeria, the consumption of fuel woods particularly charcoal, is in the increase due to urban growth and demand/consumption of energy. This study concludes that charcoal production is an important strategy by rural dwellers to diversify means of livelihood hence it is difficult to stop all the environmental challenges associated with it. However, it is obvious that charcoal production has serious environmental consequences such as loss of savanna parkland, soil erosion, loss of soil nutrients, loss of grazing land among others but there is no alternative energy to common man at an affordable rate that would substitute the existing scenario. It is therefore crucial to link the poverty situation in the study area with charcoal production.

### Recommendations

I. Currently charcoal production in the study area is carried out informally by local people. The Gombe State government under the ministry of environment and forest resources should collaborate with Local authorities to formalize the sector by identifying and registering all the charcoal producers. The charcoal producers should form an association through which they can obtain licenses for their operation.

II. Participatory forest management approach should be implemented in all the communities in the state. This should be done through involving community leaders, religious leaders, and concerned citizens who have passion in forest conservation and management to take care of existing forest within their domain.

II. The program initiated by Gombe State Government tagged Gombe Goes Green (G3) should be boosted to reach local communities

DOI: 10.56892/bima.v7i01.410

in the state and fuelwood cutter/charcoal producers should be involved in the program.

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