



Review Article

Effect of Indiscriminate Charcoal Production on Nigeria Forest Estate

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Abstract: Half of the world's population, and up to 95 percent in poor countries, rely on solid fuel including biomass fuel and charcoal to meet their energy needs. Fuel wood and charcoal are by far the most heavily consumed energy sources in Nigeria, rural dwellers who are the custodians of forests resources depend solely on it for livelihood and increase in demand for charcoal. Nigeria ranked the highest producer of charcoal in Africa and second in the world and the production trend of charcoal in Nigeria has over the years shown a steady increase yet Nigeria is not among the world leading nations in the exporting of charcoal which means the nation consumes a larger percentage of its annual produce locally. The continuous production is promotional to continuous deforestation and desertification which in-turns are a threat to sustainable environment. Thus the uses of forest trees for charcoal production still represent a threat to the future of the resources in local terms, especially in certain situations with high demand. With adequate forest management, supervision and control practices, however, the growth of charcoal use will no longer have serious impact on forested areas that supply consumption centers. Also, if measures are introduced to improve the supply of raw materials for charcoal production (through tree planting initiatives and participatory forest management), unsustainable production would gradually be replaced by regulated production on a sustainable basis.

Keywords: Charcoal, Deforestation, Desertification, Sustainable Environment, Briquette

1. Introduction

Charcoal is a portion of wood with a messy and dangerous parts heated off; often it has additives like borax, lime and nitrate [1]. Charcoal is a burnt wood, which lost all moisture and most volatile contents in the production process. As estimated in 1998, Nigeria is the highest wood producer in Africa producing more than 100 million cubic metres despite this fact, Nigeria is not among the leading nations in the exportation of charcoal. Charcoal is energy-dense light-weight (on energy value per weight), easy-to-handle, and convenient fuel, which burns without producing much smoke other than during lighting. These attribute makes it a

desired fuel especially in urban and peri-urban areas [2]. It is mostly produced in rural areas as an income generating activity and usually sold into the more urban areas where firewood collection is less feasible and people have more purchasing power to buy fuel. In Nigeria, charcoal is available in all the geopolitical zones of the country as many local communities have perfected the technology of charcoal production. In the Western zone some known charcoal depots are found in places like Oyo, Isheyin, Saki Igbo-Ora, Ogbomoso. There are also depots in Jebba, Omu Aran, Egbe, Kabba in the Central States and also in Minna, Jos and Kaduna.

2. Historical Uses and Production of Charcoal

Man's use of charcoal is an ancient practice which dates back to over 30,000 years ago when it was used to make some cave paintings. Much later, Charcoal became an integral part of the world's evolution as it played a vital role in the early technology development of man, the smelting and working of metals [3]. More so, it has continued to be a technologically relevant material, basically due to its adsorptive properties. The first documented usage of charcoal came from the black colour used in European cave paintings 32,000 years ago while its earliest use as a fuel started like 7000 years ago in the smelting of copper. During the Bronze Age in Britain, Charcoal was commonly used but as a result of the success recorded in the experimentation of converting coal to coke, charcoal began to decline as this new fuel was preferred. Over a period of hundred years afterwards most furnaces had been converted for alternative use and more than 4,000 years of charcoal as the major source of industrial fuel was gradually coming to an end. In the twentieth century charcoal was mainly used to produce "carbon disulphide" a substance used in the artificial silk industry [4]. Nevertheless, there were also other developed specialized use of charcoal. The production of wood charcoal is predominant in areas where there is an abundance of wood and it involves the piling of logged wood arranged to form a conical pile with a little space at the lower part to allow air and a central shaft to serve as a flue. The entire pile is thereafter covered with a dampened clay, fire is set at the bottom of the flue which with time spreads within the entire pile, the entire process however depends solely on combustion to be successful. Averagely 100 parts of wood produces approximately 60 parts by volume or 25 parts by weight of charcoal. Recently, as a result of economic hardship, poverty, unemployment and increment in pump-price in Nigeria, people had to find another means of making a living in respect of domestic cooking energy [5, 6]. During the colonial periods, large number of people used firewood as domestic energy fuel but after the colonial era; there was a change in status quo as people embarked more on the use of electricity, fossil fuels such as kerosene and gas as cooking energy [7].

Presently, millions of households in Nigeria use charcoal as domestic and outdoor recreational cooking energy due to epileptic power supply, scarcity and increase in the price of oil and gas [7]. UNDP estimated that 2.5 billion people are unable to use modern energy services and as a result are denied the opportunity to a better standard of living and improved economic development. Therefore, they only use traditional biomass sources such as wood fuel, animal dungs and agricultural residue [8]. In the rural communities of most African Nations including Nigeria, Charcoal serves as the major source of energy for cooking and as a source of income, it also contributes to environmental degradation as it has been estimated that increment in the urbanization results to an increment in charcoal consumption [9, 10].

2.1. Situation of Natural Resources in Developing Countries

In developing countries, the pressure on natural resources is more severe, approximately 70% of the populace are involved in subsistence-based ventures and live in the rural communities [11]. Reliance on natural resources for food and energy implies that people source for their daily needs from their immediate environment. Half of the world's population rely on biomass fuel for heating and cooking and this resulted in increment of the world's production of charcoal between 1970 and 1995 from 1362.4 million to 1875.9 million [12].

According to Charcoal Production in South Africa, both men and women are involved in different stages of charcoal production to make ends meet, though it is mainly produced from wood it can also be produced using coconut shells and crop residues [13]. This is not common in Nigeria, It is primarily produced in forested areas where wood is harvested through clear felling, selective cutting or from purposely grown plantations and burned in an unsustainable way [14]. This method of production has been constant over time. Global warming is often caused by the increase of carbon-dioxide from the atmosphere in areas where trees are felled and in turn results into environmental pollution and health problems to the rural dwellers [5, 15].

Approximately fifty percent of global forest areas are deforested on a large scale due to the anthropogenic activities of man on their biological and physical environment [16]. Charcoal production is one of the main human induced activity that give rise to deforestation in Nigeria, deforestation thereby exposes the soil to direct sunshine, reducing the soil fertility, contributing to climate variability. Nearly every nation has recognized environmental issues, principally global climate variability as a critical problem which needs an immediate action and it has become a serious driver for transformation in the global arena [17]. However, the effect of poverty among the rural and urban people tells on the environment as charcoal producers wants to meet the market demand of the charcoal users, as it brings quick returns. Though charcoal enterprise is promising in terms of income generation, cheap source of cooking energy and marketability, there is a need to either control or stop its unsustainable production because the effect of the activities involved in charcoal production widens the chances for disaster on environmental issues including health problems which are related with both greenhouse gas emissions and the deforestation of local forests and woodlands [10].

2.2. Charcoal Production and Consumption in Nigeria

Charcoal and Fuel wood are the most widely used energy sources in Nigeria, they are mostly used for household cooking [5]. In terms of production, Nigeria ranks the highest in Africa (figures 1 and 2), and second in the world [18]. There is a steady increase in annual production of charcoal in Nigeria (Table 1) yet Nigeria is not among the world's leading nations in the exporting of charcoal meaning that the nation consumes almost all that it produces. Indonesia, China and Poland led in

exportation with 21.8%, 10.6% and 8.8% respectively; Nigeria is the 25th exporting nation with only 0.9% [19]. In Nigeria, there is no controlled supply of charcoal in urban areas, and this contributes to deforestation as an increase in population in these areas results to an increase in demand for charcoal. Also due to the cost of transporting charcoal from the rural areas where it is produced to the urban areas where it is widely consumed there has been a steady increase in its price and this have inhibited the growth of small-scale traders who use wood, such as fish sellers, and has also affected household budgets. Furthermore, the use of wood presently surpasses the regrowth of forests and reforestation efforts have been very poor.

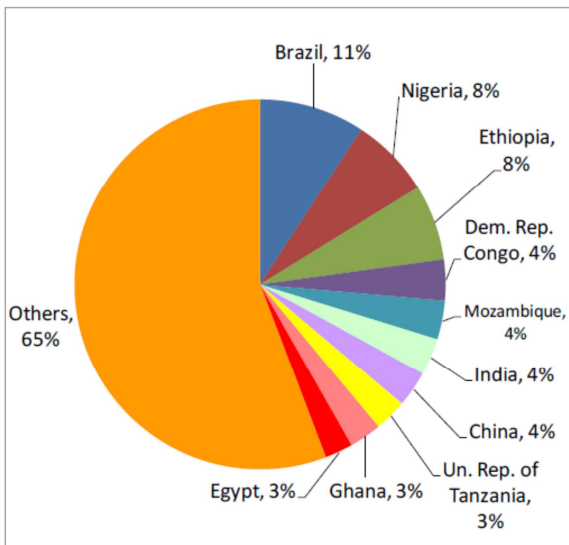
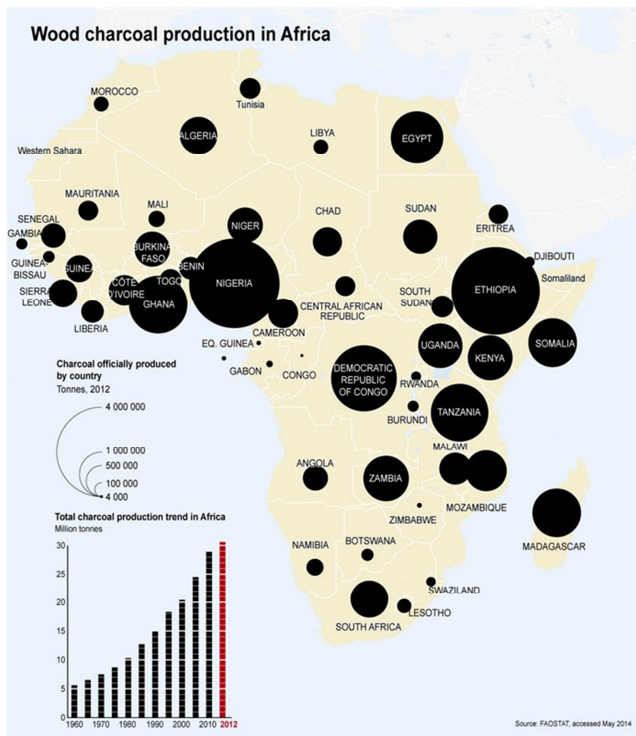


Figure 1. Top 10 charcoal producing countries.



Source: [18].

Figure 2. Charcoal production in Africa.

Table 1. Annual charcoal production in Nigeria metric tons (1990-2013).

Year	Production in metric tons
2013	4,193,352
2012	4,107,172
2011	4,022,763
2010	3,940,089
2009	3,850,113
2008	3,762,200
2007	3,676,300
2006	3,592,327
2005	3,510,292
2004	3,420,800
2003	3,333,589
2002	3,248,602
2001	3,165,781
2000	3,085,072
1999	3,006,209
1998	2,922,971
1997	2,872,535
1996	2,763,475
1995	2,646,794
1994	2,542,902
1993	2,420,873
1992	2,314,797
1991	2,210,445
1990	2,131,778

Source: Calculations from [18].

2.3. The Choice of Charcoal Among Nigerians

As reported, charcoal consumption is higher among individual and families that has low income with charcoal and fuel wood accounting for three-quarters of their total household energy expenditure [20]. In weight, charcoal might be heavy or quite light depending on the weight of the dry wood of the various species used in its production. One of the reasons why several households prefer charcoal to firewood is the fact that transporting charcoal over a long distance is less expensive when compared to firewood and also when compared to firewood it doesn't require much storage space and it can't be easily deteriorated by insects or fungal attack [21], it is also known to burn hotter and to contain twice the energy of an ordinary firewood which makes it cook faster than most other fuels such as kerosene.

Housewives prefer charcoal because its fire is very gentle, effective, easy to manage and does not to be inspected regularly unlike the wood fire which demands constant attention to prevent it from burning out. It is predominantly produced and sold locally and unlike other means of energy such as cooking gas, kerosene and electricity, charcoal is affordable and readily available and does not require any organised distribution network before the end user can access it [22]. More so, charcoal stoves are produced locally and very affordable compared to electric stove, cooking gas cylinder and kerosene stoves which are costlier. Unlike firewood it is a cleaner and a healthier fuel as it gives away little smoke (and hazardous gases) when burning. Despite all its benefits, the processes involved in its production results in deforestation and global warming thereby immensely contributing to environmental depletion [22, 10].

3. Charcoal Production and Its Impact on Nigerian Forest

In Nigeria charcoal is mainly produced in the rural areas especially areas close to forests, and transported to the urban centres after production. The production is at a sub-industrial level and it has an adverse effect on the environment locally and globally [23]. FAO indicated that from 1990 to 2005, 35.7% of Nigeria's forest cover was lost and approximately 12% of the country's land is presently forested while 350,000 hectares of land is being lost yearly to desertification [24]. The rate of fuel wood and charcoal consumption in Nigeria ranks highest in Africa and this resulted in land degradation threatens biodiversity and accelerate climate change [25]. The reduction of forest cover also reduces the existing capacity to disintegrate carbon, and release the already fixed carbon as many African nations have had over three quarter of their forest cover depleted and lost to inordinate harvest of trees.

Charcoal production is very prominent in Benue, Kogi and Niger States of Nigeria where there are guinea belts that support its production. Forests are decimated; economic trees meant for fruit production are felled for charcoal production and farm lands have been used excessively without considering its future implications on the environment. Charcoal business as well as other ventures relating to renewable energy sources is an important part of rural economy, basically because domestic energy consumption is a very important aspect of the economies of most developing Africa nations. However, there is a limit to the usage of other forms of renewable energy sources as a result of inadequate technological development. [26]. In an attempt to earn more living among rural poor, charcoal production has been considered a good business for income generation, prompted by free access to forest resources, until such forest area is being depleted. The major shift in the use of household energy particularly with charcoal, led to the intervention of 'Abacha Coal Pot', over the years which became widely accepted and used [27, 28].

3.1. Problems Associated with Charcoal Production and Utilisation

Charcoal production in Nigeria results 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 [29]. Due to the steady increase in the demand for charcoal as a result of different industrial revolutions and urbanisation, production of charcoal has been largely carried out with an unsustainable approach.

3.1.1. Air Pollution and Health Problems

Charcoals consist of carbon and any remaining ashes, it is an adulterated form of carbon containing ash. Pollutants like carbon monoxide, sulphur and other minute particles are released into the atmosphere from the incomplete and inefficient combustion of wood fuels. Chronic respiratory

diseases such as pneumonia, tuberculosis, and acute respiratory infection are associated with indoor air pollution which could be caused by charcoal. The wood smoke produced during charcoal production contains small particles of matter such as PM10 (10 Microns in diameter or less) made up of creosote soot and ash, they transport some viruses and bacteria into the lungs and blood, other constituents also include Nitrogen, Sulphur dioxide and volatile organic substances (VOCS) which poses risk to exposed persons [30]. These pollutants have a serious effect on the human health, it can result in cancer, heart and lung disease and it can inhibit the ability of the body to transport oxygen.

3.1.2. Increase Deforestation and Desertification

Forest degradation, Deforestation and outbreak of respiratory disease have been reported to be some of the major effects of relying on wood fuel and charcoal, and efforts directed at ameliorating its impact has proved abortive. The production of charcoal involves the cutting of wood over a large forest area, depletion of land covers and soil structure, this escalates the rate of wind and water erosion which can later lead to destruction of the soil fertility. More so, the use of wood for energy increases deforestation which directly escalates the problem of deforestation and desertification and also leads to the loss of forest which protects the watersheds.

3.1.3. Loss of Biodiversity

The production of charcoal has led to a massive forest depletion in Congo where it is reported to threaten the survival of mountain gorillas, similar threat was also reported in Zambia. In Brazil, Charcoal production is a big illegal industry for the manufacture of pig iron. Despite the fact that it gives the benefit heat efficiency, issues of deforestation and pollution from its smoke will always be an area of concern. Pollutions from smoke and its constituents during the process of production requires an immediate attention across every disciplines especially forestry and environmental toxicology [31].

3.2 Way Forward: Alternatives Use to Charcoal

A ban on charcoal production will not be successful if alternative source of energy is not provided. These alternatives will help prevent destructive and illegal charcoal production and also serve as a source of income generation. The suggested alternative sources are: Liquefied Petroleum Gas (LPG) and Fuel Sawdust/Biomass Briquette

3.2.1. Consumption of LPG in Nigeria

Nigeria as a nation has been reported to be more of a gas country with an estimated reserve of about 186 trillion cubic feet (TCF). However, the Nigerian LPG industry has over the years grown slowly even with the intervention of the Nigeria Liquefied Natural Gas (NLNG) in terms of regular supply of domestic LPG. There have been concerns over the low level of gas-based market growth in the industry especially

domestic LPG. Nigeria has about 186 trillion cubic feet of gas and confirmed to be of very high grade with no sulphur, placing it as the world's 7th largest gas reserves holder, but surprisingly she is among the lowest consumers of LPG or domestic gas in Africa. Official sources estimate that Nigeria's reserves potential could grow to as high as 600tcf, making it the world's 4th largest [31].

Despite obvious advantages of LPG over other domestic fuel, only five per cent of Nigeria's household use LPG. Investigations revealed that more than 80 percent of households in Nigeria still use conventional firewood and kerosene, which have been identified as major sources of emission⁷. Thus, the development of Nigeria's domestic LPG market, without doubt has continued to be affected in great measures due to choice of firewood and kerosene as energy sources for cooking. The situation is further exacerbated by various policies of the government in the sector. In 2012, Nigerians consumed a total of 145,000mt of LPG, representing an increase of 11.5 percent from the 130,000mt consumed in 2011. However, in 2014, Nigerian households consumed about 150,000mt of LPG representing just an increase of 3.33percent, leaving a huge gap from the expected annual consumption ratio of which experts believe is not the best way to grow the domestic LPG market of a country endowed with huge natural gas reserves [7].

3.2.2. Utilisation of Sawdust Briquette

Residues generated from the forests and the agricultural sector have been poorly managed and badly utilised as they are left either decompose or are burned off which leads to pollution and degradation [32]. However, studies have revealed that these residues contain a lot of potential energy and they can be used to generate heat for domestic and industrial use [33, 34].

There is no doubt that energy plays a major role in the development of a country and it largely improves the social and economic life of the people. If the problem of energy is not properly fixed, Nigeria may fail in her target to be among the world largest economy by 2020. Over the years fossil fuel has been one of the principal sources of energy, 86% of energy being consumed all over the world is from fossil fuel but due to problems associated with their application there has been a gradually shift of attention from fossil fuel in recent time [35, 36, 30].

There are many types of biomass but sawdust and agricultural residues has proved to be one of the best choice, some agricultural wastes even be used directly as fuels. Due to the fact that most of them are bulky and uneven and have a low energy density most of them are not suitable [34]. These properties make them difficult to handle, store, transport and use in their raw form [35]. There is therefore a need to convert them in order to address these problems. One of the processes through which these residues could be converted to biomass energy is briquetting.

The use of fuel wood for cooking has an adverse effect on the health especially on women and children who are

excessively exposed to the smoke [7]. It was noted that women in the rural areas often carry young children on their back or staying around them, they spend one to six hours daily cooking with fuel wood and charcoal. The exposure is much in some areas especially when cooking in a stuffy area or where wood is used for heating of rooms. The biomass smoke contained a large amount of pollutants which poses a huge risk to human health. Instead of saw dust laying unused, polluting the environment it can be turned into wealth by making fuel briquette form it.

4. Conclusion

There has been an over reliance on charcoal as a source of energy for cooking in both urban and rural areas of developing nations. The major concern is that charcoal is produced from forest resources in an unsustainable manner. Thus the using forest tree poses a threat to the future of our forest estate and biodiversity especially in areas with high charcoal demand. The introduction, promotion and utilization of briquette coupled with a good forest management, supervision and control practice will limit the effect of charcoal production on our forest estates. Furthermore, the promotion of fuel-efficient stoves will also help in reducing the unsustainable production of charcoal. Finally, if there is an improvement through tree planting initiatives and preparatory forest management unsustainable charcoal production will soon be over.

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