Economics of Charcoal Production among Producers in Kwara State, Nigeria

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Abstract: Over exploitation of forest resources for commercial charcoal production is a worrying phenomenon in Nigeria. The forest is rapidly becoming depleted due to the human quest for fuel wood. The fast disappearance of trees may influence climate change which, may in the long run affect crop yields and deepen poverty. Thus, this study estimated the costs and returns as well as the determinants of charcoal production in the study area. Data collected were analysed using farm budget and multiple regression analyses. The farm budget analysis revealed an average profit per charcoal producer per annum of ₦150,827.74. The estimated multiple regression analysis revealed that quantities of woods, labour in man-days and producers' experience are the important determinants of charcoal production in the study area. Three main policy issues emerge from the results of this study. First, there is need to promote cheap and effective fuel source like the briquette through the use extension agents. The cost of electricity, kerosene and cooking gases should be lower than charcoal and firewood. Thirdly, there is need to provide other alternative ways of life such as provision of off-season employment so as to dissuade both rural and urban dwellers from energy driven deforestation.

Keywords: Forest resources, climate change, deforestation,

INTRODUCTION

Over two billion people in developing countries rely on biomass energy in the form of firewood, charcoal, crop residues, and animal wastes to meet their cooking and heating requirements (Millennium Ecosystem Assessment MEA, 2005). About 90 % of the 1.2 billion people living in poverty worldwide rely on forests to some extent for subsistence needs.It supplies about 95 percent of the domestic and commercial cooking energy needs in developing countries (Food and Agricultural Organisations of the United Nations FAO, 2007). The links between fuel wood (firewood and charcoal) use and deforestation, as well expected fuel wood shortages has been established (Kauppi *et al.,* 2006). The number of people relying on fuel wood is expected to keep increasing with an estimate of about three quarters of total residential energy in Africa by 2030 (International Energy Agency IEA, 2002). About 11.3 million hectares of forests are lost annually to agriculture, commercial timbering, uncontrolled fuel wood production and consumption .Unfortunately, 90 percent of cleared forest are never replanted (FAO, 2000). Moreover, it has been estimated that charcoal consumption is often growing faster than firewood consumption in Africa and South America (Wurster, 2010). The impact of wood fuel and its derivative (charcoal) on the energy requirements of developing nations cannot be underscored. The growing demand for charcoal in developing countries has resulted in localised deforestation in vulnerable areas.

Charcoal is the dark grey residue consisting of Carbon and any remaining ash, produced by the slow process of heating wood and other substances in the absence of oxygen, called Pyrolysis. It is an impure form of Carbon, which contains ash. However, it is an excellent domestic fuel, and can be made from virtually any organic material like wood, coconut shells, rice husks and bones, usually hardwood species like Acacia, Mangroves, Oaks and *Prosopis* are preferred for charcoal production. Charcoal though an old source of energy, is as well still a modern source of energy for cooking in both rural and urban centres, Kammen and Lew (2005) reported that half of the world's population use biomass fuels for cooking and that in 1992, 24 million tonnes of charcoal were consumed worldwide, with developing countries accounting for nearly all consumption, while Africa alone accounted for 50%. In Nigeria, Charcoal is mainly used for cooking, roasting of suya, barbecue, maize, plantain, cocoyam and yam, blacksmithing and bronze-casting (Izekor and Kalu 2007). Charcoal in addition, is now an export commodity in Nigeria, with a large market in the EU, USA and Asia. The prices range from $170 - $300/ton. Tropical Africa accounts for 70% of the exports and the market is all year round (Essiet 2009).

Good-quality charcoal burns cleanly and produces high heat. This important property, along with its low average ash content, makes charcoal desirable for metallurgy or as a domestic fuel. In weight, charcoal may be rather heavy to quite light depending on the weight of the dry wood of the various species used in its production. Charcoal is comparatively easy to ignite, and when of good quality burns evenly and without smoking. In many developing countries, charcoal and agricultural wastes constitute a major portion of total household energy consumption (Bamiro and Ogunjobi, 2015).

Many households in Nigeria are facing challenges of inaccessible to and unaffordable of clean, less dangerous and convenient cooking fuel. Studies have shown the sources of cooking energy in Nigeria to include electricity, liquefied natural gas (popularly known as cooking gas), kerosene, charcoal, firewood, wood waste, and agricultural waste (Zaku et al; 2013). The use of any of these sources of cooking fuel by a household has been faced with some challenges and also depends on the affordability, preference and availability. There has been long years of inconsistence in the supply of electricity while kerosene is faced with persistence scarcity and increase in price. The cooking gas is also very expensive and out of reach for the poor and low-income class (Babalola, 2011). The economic impact on households therefore led to either a switch in the choice of energy preferred for domestic use or a situation of energy combination by different income groups. Many of the people in the rural areas, as well as low-income class in the urban areas therefore preferred to switch to charcoal or firewood which they considered less expensive and available (Zaku et al 2013).

Furthermore, Nigeria is the largest oil producer in Africa holds the largest natural gas reserves on the continent and was the world's fourth leading exporter of liquidified natural gas. Despite these abundant resources many people in the country still rely on biomass energy in form of firewood, charcoal, crop residues and animal waste (Zaku et al 2013). Thus, this study determine factors influencing charcoal production, examine the costs and returns and identify the challenges facing charcoal production in the study area.

METHODOLOGY

Study area: The research was carried out in Moro Local Government Area of Kwara state, Nigeria. The LGA area is bounded by Kaima LGA in the West, Ifelodun and Edu LGAs in the North-east, Ilorin East and Ilorin West LGAs in the East and Asa LGA in the South. The headquarter is located at Bode-Saadu. The state was created on May 27, 1967 along with eleven other states in the federation. The state lies between latitude 7^{o} 45N and 9^{o}30N and longitude 2^{o}30E and 6^{o}25E. The annual rainfall ranges between 1,000mm and 1,500mm. Average temperature ranges between 30^{0}C and 35^{0}C. The state has a land area of about 32,500 square kilometers and shares boundaries with Niger state in the North, Kogi state in the East, Ondo and Osun states in the South and Oyo state in the West, it also shares an international border with Republic of Benin. According to the 2006 National Population Census report, the population of Kwara state stood at 2.73 million. Popular ethnic groups found in the state include; Yoruba, Fulani, Batunu, Nupe, Bokobanu and Gambari. Over 90 percent of the rural populace is involved in farming (Kwara Ministry of Information, 2004). The state has two main climatic seasons; the dry and wet seasons.

The natural vegetation of the state comprises the wooden and rain forest savannah. Major land forms in the state are plains, undulating hills and valleys. The favourable climate and the large expanse of land makes the wooded savannah in the state well suited for the cultivation of a wide variety of crops including cereals, tubers, legumes and vegetables like spinach, okra etc**.** The state is classified into four agro ecological zones by the Kwara State Agricultural Development Project (KWADP). The classification is based on the ecology and administrative convenience. These are: Zone A: Baruteen and Kaima Local Government Areas; Zone B: Edu and Patigi Local Government Areas; Zone C: Asa, Ilorin East, Ilorin West, Ilorin South and Moro Local Government Areas; and Zone D: Ekiti, Ifelodun, Irepodun, Offa, Oyun, Isin and Oke-Ero Local Government Areas.

Sources of data: Primary and secondary data were collected for the study. Secondary data involved desk study and/or review of relevant literature such as journals, technical documents, government gazettes, CBN annual reports and bullions, and published materials from the National Bureau of Statistics and the National Planning Commission (NPC), among others, Internet resources were also consulted. Primary data were collected with the aid of structured questionnaires.

Sampling method: The charcoal producers in Moro LGA of Kwara state constitute the target population for this study. A three-stage sampling technique was used to select sample for the study. The first stage involved purposive selection of Moro LGA. The choice of this area was informed by preliminary investigation which revealed that charcoal production is prominent in Moro LGA than other LGAs of Kwara state. This may be due to its proximity to Oyo State where charcoal production is more pronounced in the south western Nigeria forest zone. Also, based on the fact that observations have been made about charcoal production in this area, as charcoal kilns are usually seen and trucks loaded with tonnes of charcoal were also usually seen moving out of the area. In the second stage, 10 producers' associations were randomly selected from 15 producers' association in the LGA. In the third stage, 12 producers each from the 10 different associations were randomly selected to make up a sample size of 120 producers.

Data analysis: Data collected on the socioeconomic characteristics and challenges facing

charcoal producers were analysed using descriptive statistics such as percentages, means/averages, and frequency tables. Data collected on the factors influencing charcoal production in the area were analysed using Multiple Regression Analysis. Also, data collected on the profitability of charcoal production were estimated using Gross Margin Analysis.

Multiple Regression Models involve the use of three functional forms (Linear, Double Log, and Semi-log forms). Best Linear Unbiased Estimates (BLUE) the one that had the highest R^2, better F ratio and high significant coefficient was selected as the lead equation. The implicit form of the models were given by

$Y = f(X_1, X_2, X_3, X_4, X_5 + u)$.

Where

Y = Charcoal production in naira

X_1 = Labour in naira;

X_2 = Wood in number of trees

X_3 = Water quantity in litres

X_4 = Experience in years

X_5 = Educational status (dummy variables; formal education = 1, informal education = 0)

The explicit forms of the models are:

$Yt = bo + b_1Xt_1, + b_2Xt_2 + b_3Xt_3 + b_4Xt_4 + b_5Xt_5 + u$ … Linear Form

$Yt = bo + b_1\ln Xt_1, + b_2\ln Xt_2 + b_3\ln Xt_3 + b_4\ln Xt_4 + b_5\ln Xt_5 + u$…Semi-log

$\log Yt = bo + b_1\ln Xt_1, + b_2\ln Xt_2 + b_3\ln Xt_3 + b_4\ln Xt_4 + b_5\ln Xt_5 + u$ … Double log

Where, ln = natural log to base e

bi = coefficients of the explanatory variables

U = stochastic error term

The Gross Margin (GM) analysis focuses on the returns to the producer after the total variable cost of production has been deducted. The model for estimating the GM is outlined thus:

Gross value of output (GVO) which was obtained by multiplying the total output with market prices of output expressed in naira.

Less Total variable cost of production (**TVC**) comprised expenses (direct and imputed) on wood, water, mechanical services, hired labor, transportation and marketing etc.

Equals Gross margin (GM) (Tsoho, 2004).

Or

$GM = TR - TVC$

Where

GM = Gross margin of charcoal producers per annum

TR = Mean total revenue per charcoal producer per annum

TVC = Mean total variable costs per charcoal producer per annum

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

Table 1 shows the socioeconomic characteristics of the charcoal producers in the study area.

Table 1: Socioeconomic characteristics of respondents

Variables	Frequency	Percentage
Gender		
Male	112	93.3
Female	8	6.7
Age		
30-39 years	9	7.5
40-49 years	68	56.6
50-59 years	41	34.2
60 and Above	2	1.7
Marital Status		
Single	37	30.8
Married	83	69.2
Primary occupation		
Farming	71	59.2
Security guards	18	15
Bike rider	20	16.7
Drivers	3	2.5
Others	8	6.7
Educational Status		
No Formal Education	60	50
Primary Education	37	30.8
Secondary Education	13	10.8
Quaranic Education	10	8.4
Experience		
1 - 9years	19	15.8
10-19 years	59	49.1
20-29 years	27	22.5
30 and Above	15	6.7
Most preferred trees for production		
Prosposis Africana	74	62.5
Acacia spp	27	22.5
Azadirachta indica	8	6.0
Burkea africana	6	5.0
Psuedocedreta kotchy	5	4.0
Total	120	100

Source: Field Survey, 2014

Table 1 revealed that charcoal production is dominated by males (93.3%) compared to females (6.7%). This is not surprising because the operation is backbreaking and full of drudgery. There is a large age spread between charcoal producers that varied between 18 and 60 years. The activity appears to be dominated by the 40-49 (56.7%) age bracket. This is also not surprising since this is generally the most active age group in human life especially that the activity is an energy sapping one. Only 1.7% of the respondents are above 60 years of age. This set of

people can no longer carry out the laborious activities in charcoal production effectively. About 69.2% of the respondents are married with an average family size of five people. This influences charcoal production because a large family size will help cut labour cost. Majority of the respondents (59.2%) are farmers. This is not surprising because the primary occupation of the people of Kwara state is farming, while the remaining does a wide variety of occupation which includes bike riders, drivers, security guards, traders and bricklayers. About 46.7% of the respondents claimed charcoal production is a secondary occupation although, this was previously a coping strategy which has turned to a secondary occupation. This is similar to practices in Asia and other parts of the world as reported by Bhattarai, 1998. Nonetheless, it is a worse alternative because of the drudgery and health risks involved in charcoal production. For example the heat emanating from most of the kilns when picking burnt charcoal range between 30°C-40°C and fumes exuding from the carbonized wet-wood are perhaps poisonous but certainly irritate the eyes. In fact about 85% of respondents claimed that they will abandon charcoal production if there are better alternatives. Almost half (46.7%) of the respondents are full time producers.

The most (62%) preferably used tree is *Prosopis Africana.* This is due to its hardness and non-bristling quality. *Acacia spp* (22.5%) ranking second, *Azadirachta indica* ranking third, *Burkea africana* was ranked fourth and lastly *psuedocedrela kotchy* was ranked fifth. Other trees used as alternatives such are: *Terminalia macroptera, Anogeissus leiocarpus* and *Tamarindus indica.* Although any hard savanna tree could be carbonised for charcoal, the first five species identified above were mostly sought after. The preference ranking has a serious consequence for the environment and sustainable development. It implies that these preferred species will be extinct earlier than other species. As at present, searching for these species into the depth of the savanna forest has increased. However, some trees were not mostly felled for charcoal production. These trees includes: Teak, *Tectona grandis.,* locust bean tree, Tamarind tree, Shea butter tree, because they are considered to be of local economic importance. Also wet trees and trees that yield edible fruits are also not usually felled.

Gross margin analysis

The mean total revenue, total variable and fixed costs per charcoal producer per annum were ₦193,916.67, ₦31,794.56 and ₦11,294.36 respectively. Leaving a profit of ₦150,827.74 per charcoal producer per annum

Regression Analysis

Based on the criteria, the double log function was chosen as the lead equation. It has coefficient of multiple determination (R^2) of 0.893. Indicating that about 89 percent of the total variation in output was explained by the independent variables (Table 2). Although, linear function has the highest R2 value (0.943), the double log production function has been the most widely used in agricultural economics especially where interest revolves around quantitative estimates of returns to scale and resource productivities at the means of inputs. The labour quantity (X_1), wood quantity (X_2), and level of experience (X_4) are significant at 5% level. This implies that these variables are very important in production of charcoal and an increase will lead to increase in output. The lead equation can be presented thus:

$$Y = 1.044 + 0.667X_1 + 0.275X_2 - 0.082X_3 + 0.216X_4 - 0.024X_5$$

Table 2: Regression Analysis of Charcoal Producers

Functional form	Constant	X_1	X_2	X_3	X_4	X_5	R^2	F-value
Double log	1.044	0.667	0.275	-0.082	0.216	-0.024	0.893	200.132
	0.180	17.757*	4.070*	-1.456	4.901*	-1.316		

SOURCE**:** Computer printout data. *Significant at 5% level.

Challenges facing charcoal producers

One of the challenges facing charcoal production is health hazard. Table 3 indicates that 20.8% of the respondents suffer some form of irritation. They were however able to characterise them in to common types of irritation such as difficulty in breathing, coughing and tearing in the eyes. Also they suffered from fatigue and body aches. All these are associated with heat, Volatile Organic Compounds (VOCs) and carbon monoxide Northeast States for Coordinated Air Use Management (NESCAUM 2006). Most respondents said they normally take drugs such as Panadol (paracetamol), milk and hot water with robb (methylated balm) to recover. The technology itself has to do with channelling of smoke or vents. Depending on the expertise of producers, they can evade smoke problems to varying degrees. This may cause grievous health challenges such as lung, blood oxygen absorption problems and even cancers (Nescaum 2006, Anon, 2011).

High cost of labour is also a problem. About 73% of the respondents claimed labour influences their production. Fifty-three percent said they make use of family labour, comprising their wives, wards and children, which cost less. On the other hand, 47% of the respondents claimed they make use of non-family labour. This form of labour is either paid for annually, monthly or per charcoal kiln. The labour activities include felling of trees, cross cutting into short logs, construction of charcoal kilns among others. On an annual basis, a worker is paid an average of ₦70,000. Though this form of labour can work for more than one charcoal producers depending on the schedule of work. On a monthly basis, they are paid between ₦5,000 and ₦10,000 depending on the type of work done. This depends on the bargaining power of the producers and type of work to be done. However, the commonest mode of payment of labour usually used is per charcoal kiln, which are normally paid in man-days. Other challenges facing producers are: high cost of transportation, sourcing for marketers or buyers, laws against felling of trees, and high level of tax paid to government.

Table 3: Most important challenges facing charcoal producers

Challenges facing charcoal producers	Frequency	Percentage
High cost or unavailability of transportation	17	14.1
Sourcing for marketers/buyers	25	20.8
Level of tax paid to government	14	11.7
Law against felling of trees	29	24.1
Health hazard	25	20.8
High cost of labour	10	8.3
TOTAL	120	100

SOURCE: Field Survey, 2014

CONCLUSION AND RECOMMENDATIONS

This study set out to estimate the costs and returns as well as the determinants of charcoal production in the study area. Most charcoal producers are males, with an average age of 32 years. They have an average production experience of 7 years and mostly have no formal education. Majority of them are married with an average household size of 5 persons. The production of good charcoal requires the use of very hard woods; this has led to the preference of some trees over the other. The most preferred tree is *Prosposis africana* which produces dense good charcoal. The challenges facing charcoal producers in the area includes health challenges which includes irritation from smoke, fatigue and body ache, coughing, difficulty in breathing and tearing in the eye. Other challenges are high cost of labour, high cost of transportation, sourcing for marketers or buyers, high level of tax paid to government and the legislation against felling of trees. The profit per annum (₦150,827.74) from charcoal production which is more immediate than proceeds from sale of agricultural produce will continue to lure deprived rural dwellers to charcoal production despite the drudgery and health-risk associated with the production. Factors determining the charcoal production in the area are quantity of woods, labour in man-days and producers' experience. Three main policy issues emerge from the results of this study. First, there is need to promote cheap and effective fuel source like the

briquette through the use extension agents. The cost of electricity, kerosene and cooking gases should be lower than charcoal and firewood. Thirdly, there is need to provide other alternative ways of life such as provision of off-season employment to prevent further deforestation.

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