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ASSESSMENT OF ENVIRONMENTAL IMPACTS OF CHARCOAL PRODUCTION IN GUMMI LOCAL GOVERNMENT AREA, ZAMFARA STATE, NIGERIA

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ABSTRACT

Despite the challenging environmental problems such as drought and desertification phenomenon facing northern Nigeria particularly the eleven frontline states, unsustainable harvesting of trees for domestic cooking fuel is alarming and it may exacerbate deforestation and many environmental problems. A survey was conducted where 88 charcoal producers were identified, selected, and administered with a semi-structured questionnaire in some charcoal-producing villages in Gummi Local Government Area, Zamfara State. Information collected include charcoal-producing areas, the most preferred trees for charcoal production, charcoal production procedures monthly income of the producers, problems encountered, and impacts of charcoal production on the environment. The data collected were analyzed using Descriptive and Inferential Statistics. The study found that 100% of the respondents were males and 34.40% were married. Majority of charcoal producers (68.18%) had no formal education. The findings revealed that charcoal production is a profitable business because, on monthly basis, 41% of the producers averagely earn up to the national minimum wage (₦29,000-₦38,000). Chi-square test was used to assess charcoal producer's educational qualification and their awareness of environmental changes. The results revealed a highly significant relationship χ (4) = 13.600^{a}, and P ≤ 0.001. Although charcoal production serves as a source of livelihood for teaming

youths, however, indiscriminate felling of trees in these areas with already depleted forest resources should therefore be strictly regulated.

Keywords: Impact assessment; environment; charcoal production

INTRODUCTION

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Energy is a pre-requisite of any nation for social and economic development. In many tropical developing countries, energy in the form of fuelwood and charcoal is the primary source of energy for domestic requirements. Nearly 2.7 billion people globally depend on solid unprocessed biomass (fuelwood, cattle dung, and agricultural residue), and coal as their primary cooking fuel. According to The Solar Cooking Archive (2011), Nigeria's fuelwood consumption as a percentage of energy was estimated at 87%. This suggested that majority of the Nigerian rural people had been using and still use dried biomass fuels for domestic energy needs. According to FAO (2010), Nigeria is one of the most deforested countries globally. However, most indigenous trees are rampantly exploited for their excellent wood fuels without taking into consideration the slow nature of their regeneration. Recently, Nigeria is among the second largest producers of charcoal and also among the largest consumers of charcoal worldwide (Rotowa *et al.*, 2019). In Nigeria, Nwofe (2013) lamented that, lack of readily available and cheaply affordable alternative fuels in most parts of Nigeria is what prompted many households into using charcoal for domestic cooking. Traditionally, all tree species can be carbonized to yield charcoal but as a matter of preference, some tree species are selected over others because of the high quality and quantity of the charcoal they produce.

Fuelwood harvesting in developing countries is so vital that it competes with other energy sources for domestic uses. The demand for wood fuel is growing in line with population growth; the annual growth demand is between three and four percent depending on the country (Luwaya, 2015). The use of wood fuel for domestic cooking by low-income households is exacerbating deforestation in the developing countries where meeting energy demand for the growing population is a daily challenge (Luwaya, 2015). Consequently, tree species such as *Prosopis africana*, *Vitellaria paradoxa*, *Diospyros mespiliformis, and Vitex doniana* among others; have become threatened in the study area. A few decades ago, charcoal production in northern Nigeria was not so pronounced as many households did not show interest in using charcoal as a source of cooking energy. Charcoal was mainly used for black-smithing, gold-smithing, and other peripheral uses at home, and as such had a negligible impact on the environment. This research therefore purposively selected those areas that are prominent in the production of charcoal, the kiln type, their monthly income, the most preferred species as well as the impact of charcoal production on the environment. However, the trend of forest exploitation for charcoal production is on the increase even in northern Nigeria. In the rural settings, charcoal is produced via the slow pyrolysis of wood in traditional earth kilns (earth-pit and earth-mound kilns), which involves burying wood in pits and mounds completely covered with soil, allowing little or no oxygen. Most research on charcoal production in Nigeria focussed on socio-economic perspectives. However, reference works that capture the effects of charcoal production on the environment are not documented.

MATERIALS AND METHODS

The Study Area

The study was conducted in Gummi Local Government Area of Zamfara State. It is located between latitudes 12° 08' 30" N to 12° 09' 28" N and longitudes 5° 07' 30" E to 5° 11' 41" E. The estimated human population of Gummi Local Government was 204, 539 (NPC, 2006; NBS, 2010). Zamfara state falls in the Sudan savannah ecological zone of Nigeria, characterized by scattered trees that are mostly xerophytes. The dominant tree species include *Acacia* species, *Piliostigma reticulatum*, *Parkia biglobosa*, *Anogeissus leiocarpus*, *Adansonia digitata*, *Zizipus spina-christi*, *Prosopis africana*, and *Combretum nigricans* among others (Zhigila *et al.*, 2016). The rainy season usually starts in June and ends in October. The mean annual rainfall ranges between 600-700mm, and the mean annual temperature is between 32^0C to 36^0C. The major occupations of the people in the study area are cultivation of crops such as arable crops, vegetables, tubers, and calabash. Animal husbandry, fuelwood collection, charcoal production, and wood carving are the supplementary sources of livelihood (NBS, 2010).

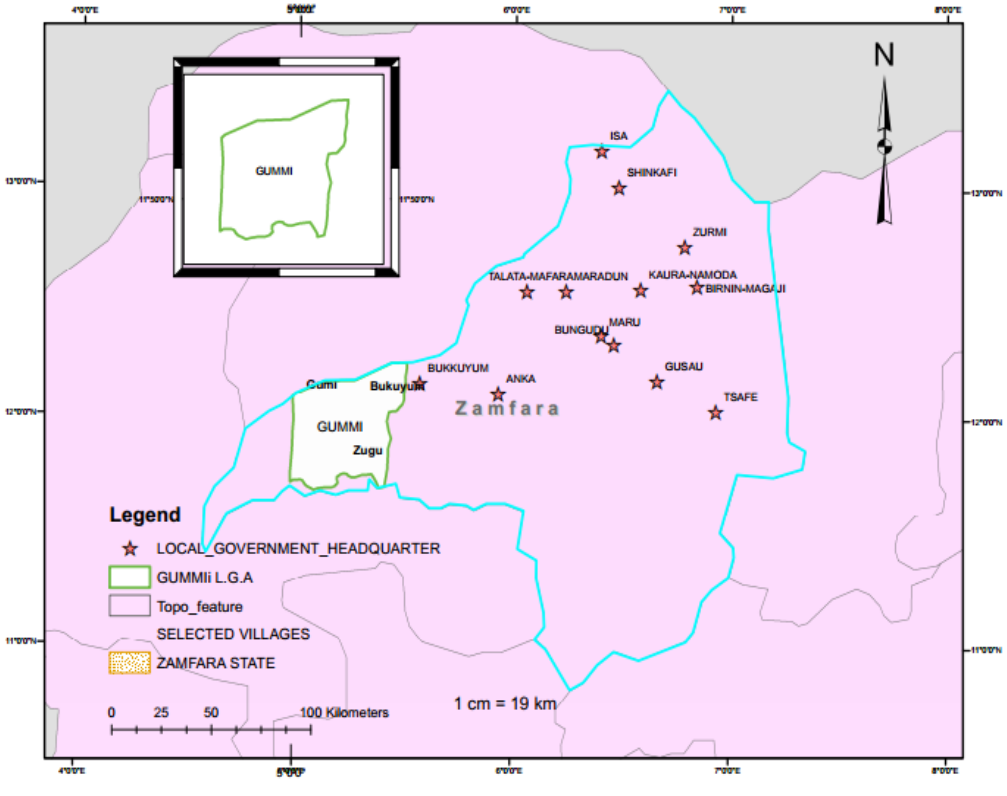

Fig. 1: Map of Zamfara State Showing Gummi Local Government Area

Sampling Procedure Data Collection

A semi-structured questionnaire was used as the main instrument for data collection. Four charcoal-producing localities in Gummi Local Government area were purposively sampled based on their predominance in charcoal production. The four localities were Gummi town, Zugu, Bukuyum, and Golli. Charcoal producers in the selected villages were identified using the snowball sampling technique, in which a total sample size of 88 respondents were identified for this study. Data were collected on tree species preference, methods of charcoal production, and monthly income, among others.

Data Analysis

The data collected were organized in Microsoft Excel and exported to the Statistical Package for Social Sciences (SPSS) for the analyses. Descriptive Statistics was used for the summarization of data into frequencies and percentages. Chi-Square test of association was used for testing the relationship between the educational qualification of the respondents and their knowledge of changes in the environment.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

Socio-economic characteristics of charcoal producers are presented in Table 1. The results showed that 100% of the respondents involved in charcoal production in the study area were males. Charcoal production is energy demanding hence the preponderance of males in the business which invariably determines the productivity. The findings of this study agreed with Ali *et al*. (2018) who reported that males constitute the majority in millet production management practices. While the predominance of married people is an indication of the fact that married people are in most cases, more than their unmarried counterparts in saddling with the socio-economic responsibilities of their families. However, majority (68.18%) of the producers have no formal education, this could be attributed to the fact that majority of the respondents probably joined the business just to earn a living.

Furthermore, 55.68% of the respondents are within the age bracket of 28–37 years; this implies that the charcoal producers were within their active and productive age. This is not surprising since this is generally the active age group in human life especially that the activity is an energy exacting one. This conforms to the finding of Oladimeji *et al*. (2018) who reported that labour productivity is a function of age. The results further revealed that 38.30% were married, and 26.60% had a household size of 6-10 persons. The results further revealed that 38.30% of the producers had between 6-10 years of experience in charcoal production activities. 52.30% are predominantly farmers. The results conform to the findings of Simeon *et al*. (2019) in Kakau Daji who reported that the main occupation of 55% of those in fuelwood exploitation is farming. The years of experience of the charcoal producers indicate that commercial charcoal production is profitable and recently blooming and thus serve as an important source of livelihood. 47% of the producers had a monthly income of between ₦29,000 to ₦38,000. This is in line with the findings of Simeon *et al*. (2019) who reported that 55% of fuelwood sellers earned between ₦20,000 to ₦30,000 monthly.

Table 1: Socio-economic characteristics of the respondents (n=88)

Variables	Frequency	Percentage
Gender		
Male	88	100
Age (years)		
18-27	25	28.41
28-37	49	55.68
38-47	9	10.23
48-57	5	5.68
Marital status		
Married	44	34.40
Single	37	28.90
Divorced	5	3.90
Widow	1	0.80
Widower	1	0.80
Household size		
1-5 persons	19	14.80
6-10 persons	34	26.60
11-15 persons	17	13.30
16-20 persons	11	8.60
21 and above	7	5.50
Educational level		
Tertiary Education	0	0.00
Secondary school cert.	5	5.68
Primary school cert.	23	26.14
No formal Education	60	68.18
Years in charcoal prod.		
1-5	23	18.00
6-10	49	38.30
10 and above	16	12.50
Primary occupation		
Charcoal Production	27	30.70
Farming	46	52.30
Others	15	17.00
Monthly income (₦)		
<18,000	9	10.23
18,000-28,000	11	12.50
29,000-38,000	41	47.00
39,000-48,000	24	27.27
above 48,000	3	3.41

Vegetation Change Assessment

The results in Table 2 showed that the highest percentage (69.3%) of the respondents attributed the cause of vegetation loss to unsustainable harvesting of wood fuels. Whereas the least with 4.5% of the respondents viewed that climate change could be the major contributing factor to the loss of vegetation. The findings of this study, therefore, corroborate with the findings of FAO (2010a); Na'ibbi *et al.* (2013) that fuelwood collection for domestic cooking could be the major factor responsible for rapid vegetation loss in Nigeria.

Table 2: Responses on the major causes of vegetation changes in the study area

Causes of vegetation changes	Frequency	Percent
Climate change	4	4.5
Agriculture	10	11.4
Fuelwood collection	61	69.3
Population expansion	13	14.8
Total	88	100.0

Responses on how to enhance vegetation cover and curtail environmental challenges are presented in Table 3. The results showed that majority of the respondents (59.1%) suggested that embarking on massive afforestation and reforestation projects could reduce pressure on forests in the study area. The findings agree with the findings of Ilu *et al.* (2020) where majority of the respondents (90%) reported that tree embarking on planting exercises could be the only way to salvage our already depleted forest from further deterioration and for a better and conducive environment.

Table 3: Measures for combating vegetation changes

Respondents	Frequency	Percent
Through strict law enforcement	15	17.4
Through public enlightenment on the dangers of charcoal production on the environment	20	22.7
By embarking on massive afforestation	52	59.1
By practicing agroforestry	1	1.3
Total	88	100.0

Perceptions of the respondents on the indicators of changes in the environment are presented in Table 4. The results showed that the incessant occurrence of the violent winds and very harsh weather being the highest indicators of the environmental changes caused by unsustainable tree harvest for fuelwood and charcoal production in the study area with 34% and 30% responses respectively. This conforms to the findings of Ilu *et al.* (2020) who reported that rampant harvesting of trees for fuelwood for domestic uses resulted in the reductions of number and size, thus predisposes the environment to violent wind that causes property damages.

Table 4: Perceptions on the environmental changes due to deforestation in the study area

Respondents	Frequency	Percent
Frequent occurrence of violent winds	34	38.63
Reduction in the number of trees	7	7.95
Very harsh weather	30	34.10
Appearance of wind and water erosions	9	10.23
Gradual disappearance of some keystone species	8	9.09
Total	88	100.0

Table 5 presents the responses on major problems faced by charcoal producers in the study area. The results showed that majority of the respondents (44.32%) faced some financial challenges in the production processes such as payment of hired labour and high cost of transportation from the production site to the urban markets. The findings of this study conform to that of Ali *et al.* (2018) who reported financial constraint as the major impediment to production.

Table 5: Major problems encountered in charcoal production

Respondents	Frequency	Percent
Inadequate Fund	39	44.32
High cost of transportation	20	22.73
Security challenges	9	10.30
Poor road network	8	9.10
Poor markets for selling the product	10	11.40
Lack of adequate storage facilities	2	2.27
Total	88	100.00

Results of Chi-square Test

Cross-tabulation between educational background of respondents and awareness of the environmental changes was conducted and presented in Table 6. The results revealed there was a highly statistically significant association between the educational qualification of the respondents and their knowledge on the changes in the environment with Chi-square value $\chi\,(4) = 13.600^{a}$ ($p<0.01$). This suggested that despite the predominance of people with low educational backgrounds among the charcoal producers, however, educational qualifications significantly contribute to the knowledge of the environmental changes.

Table 6: Educational background of respondents * knowledge on changes in the environment

	Value	D.f	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.600[a]	4	0.001
Likelihood Ratio	19.089	4	0.001
Linear-by-Linear Association	10.576	1	0.001
N	88		

Figure 3: A motor truck loaded with charcoal from Gummi L.G.A Zamfara State to Sokoto State

Figure 2: A photo of earth-mound charcoal production kiln in the study area

CONCLUSION

It could be concluded that charcoal production in the study area is on the increase despite the state is facing many challenging environmental problems such as drought and

desertification. Massive harvesting of trees for charcoal making will continue to occupy an important position in Nigeria's energy ladder. The charcoal business blooms recently, serving as a very important livelihood source for rural people. However, it is destructive to the already depleted vegetation due to the low energy use efficiency in the production and consumption of charcoal in Nigeria. Therefore, since there is no readily available and cheaply affordable cooking fuel for domestic use, rampant production of charcoal should be strictly regulated as it may exacerbate deforestation.

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