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SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF CHARCOAL PRODUCTION IN ADOKA, OTUKPO LOCAL GOVERNMENT AREA OF BENUE STATE, NIGERIA

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ABSTRACT This work studied charcoal production in Otukpo Local Government Area (LGA) to ascertain its socio-economic and environmental impacts in Adoka communities. Villages involved in charcoal production were identified using snowball sampling techniques. A Multi-stage sampling was employed to select respondents. Personal interview with semi-structured questionnaire was employed for data collection. Five villages were purposively selected from two Council Wards in the LGA. Five (5) Charcoal producers and marketers were also purposively selected in each village for administration of questionnaire. Data collected were analyzed using one-way Analysis of Variance (ANOVA) with Duncan Multiple Range used as follow test where the is significant. Descriptive statistics such as tables and charts were used for result presentation. Results revealed that males (80%) were higher than females (10%) in charcoal production in Adoka. Youths between ages of 21 – 30 years (58%) with secondary education (58%) were foremost in the business. *Prosopis africana* was the most preferred tree species used for charcoal production. A number of trees (150 trees) were felled per week in Adoka-Ehaje to production charcoal while 68 trees felled were in Adoka-Icho weekly. On monthly bases, charcoal producers in Adoka-Ehaje earned ₦301,000 and above, while in Adoka-Icho ₦251,000 – ₦ 300,000 was earned monthly. In Adoka-Ehaje, 44.8% earnings from charcoal were used for feeding and clothing and 24.14 %was used for building of houses and payment of school fees respectively. While in Adoka-Icho, payment of school fees, feeding and clothing and building of houses (35%, 30% and 25%) were observed as socio-economic benefits from charcoal production. Respondents claimed that soil erosion was the highest (30.43%) impact of charcoal production in Adoka followed by climate change, loss of habitat, loss of watershed, extinction of plants and land dispute (27.77%, 26.32%, 11.11% and 10.53%), respectively. It was concluded that although charcoal production in Adoka communities of Otukpo LGA contribute positively to socio-economic livelihood of respondents, it negatively impacts the environment by means of soil erosion, loss of habitat and climate change.

Keywords**:** Adoka, charcoal, environment, trees, wood, soil, earnings.

INTRODUCTION

Throughout human history, forests have been a significant source of energy to man. Traditionally, different forms of forest biofuel like firewood and charcoal used for heating and cooking are still been used in many parts of the world (Global Forest Atlas, 2017). Tree and its wood have played a prominent role in human life throughout history and are believed to be most versatile raw material the world has ever known. Throughout history people depend on wood for varying needs such as fuelwood, charcoal production, pulp and paper making, building materials among others.

Wood is defined as a porous and fibrous structural tissue found in the stem's roots of trees and other woody plants. Awoyemi *et al*., (2006) reported that wood is readily available all over Nigeria and that many local communities use it for charcoal production. A lot of charcoal is produced in Nigeria without adequate data for the volume of production. Some known charcoal deports are found in places like Oyo, Isheyin, Saki Igbo-Ora, Ogbomoso- all in the western part of the Nigeria. Other identified

charcoal depots in Nigeria are located inJebba, OmuAran, Egbe, Kabba in the Central States. Charcoal is also found in abundance in Minna, Jos and Kaduna. William and Pinto (2008) pointed out that the business of trading in charcoal has now become a very lucrative venture in Nigeria. Charcoal trading business is a lucrative one for anyone involved in it, whether as a retailer, wholesaler or supplier.

Uses of charcoal include fuel in cooking, barbeque and heating and casting bronze and other metals. Charcoal is also being used by food sellers and caterers who cook for large gatherings and some households, who use it as an alternative source of energy because it is cost effective in comparison to petroleum products. One of the advantages of charcoal is that it can be

produced year-round from hardwood but better during dry season from November to May.

Charcoal is one of the major components wood pyrolysis. Wood charcoal is processed from wood and wooden materials: from trunk, branches and root of trees and shrubs processed by burning or subjecting wood to very high temperature (Jamala *et al.*, 2013). Charcoal is the dark grey residue consisting of carbon. It is produced by a low process of heating wood and other substances in the absence of oxygen, called pyrolysis. It is an impure form of carbon, which contains ash. Charcoal is an excellent domestic fuel, and can be made from virtually any organic material like wood, coconut shells rice husks and bones. It has been reported that hardwood species like Acacia, Mangroves and Prosopis are preferred for charcoal production (Bhattarai, 1998). Adeniji *et al*. (2015) reported that for many urban poor, charcoal provides a reliable, convenient and accessible source of energy for cooking at a stable cost. The authors further stated that while electricity and gas might be considered the most desired cooking fuels in urban areas, even if these were available, the majority of poor households may not be able to afford both the energy. Many households in Nigeria turned from using kerosene to charcoal or firewood because the former is very scarce and expensive for the rural poor. In Benue State, charcoal and firewood are mainly used for cooking.

Although studies on charcoal production and sales have been carried out in Gwer West, Gwer East, Makurdi and Guma LG As -by Ekhuemelo *et al*, (2017; 2019), not much have been known and documented on charcoal production in Otukpo LGA of the State. Therefore, the aim of this study was to assess charcoal production and its impact on the environment and livelihoods of indigenous people of Adoka in Otukpo LGA of Benue State.

MATERIAL AND METHODS

Study Area

The study was conducted in Otukpo LGA located on latitudes 7º and 7º30' N, and longitudes 8º00' and 8º30'E. Otukpo LGAhas its Headquarters in Otukpo town which is centrally located in Idoma Land. It is the oldest and most developed LGA in Idoma land. The LGA is bordered to the north by Apa LGA; to the south by Obi, Ado and Okpokwu LGAs; to the east by Gwer West and Gwer East LGAs and to the west by Ohimini LGA and Ankpa LGAs of Kogi State. The mean annual rainfall ranges from 1,550 mm and 2,200 mm and the temperature is between 23 and 37 °C (Ankidawa *et al*., 2018).

Otukpo LGA is known for rice, yam, cassava, guinea corn and maize production. The LGA also has rich Forest Reserves hence the presence of many Timber Sheds in the area. It also has rich tree diversities like, *Danielli aoliveri Vitellaria paradoxa, Irvingia gabonensis, Dacryode, edulis, Annona senegalensis, Afzelia africana, Ficus species, Parkia biglobosa, Prosopis africana, Acacia species, Borassus aethiopum, Adansonia, digitata* and *Tamirandus indica* among others (Ancha *et al.*, 2021). Otukpo LGA experiences both wet and dry seasonswhich varies from year to year. The rainy season starts from April and continues through October with the highest peak in August and September. The soil of the study area is generally ferruginous in nature dominated by clay, loamy and sandy.

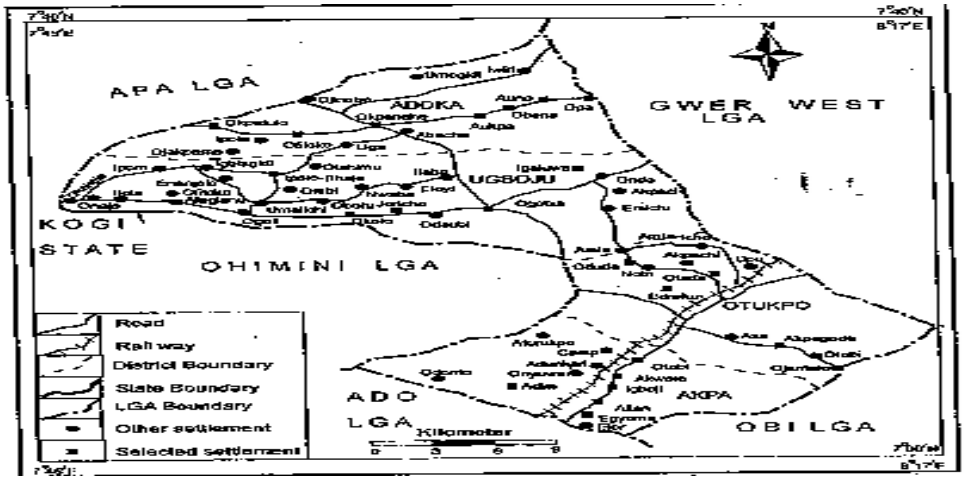

Figure 2: Map of Otukpo Local Government
Source: Ministry of Land and Survey Makurdi (2010)

Experimental Design and data collection

The villages where charcoal production is done in Adoka were identified with snowball sampling techniques described by Ekhuemelo *et al*., (2017). The target groups for this study were charcoal marketers, farmers and villagers. Identified charcoal producing villages were randomly selected and visited. A Multi-stage Sampling Technique was applied in the selection of respondents. Two (2) Council wards were purposively chosen from which five villages (Onipi, Adoka Centre, Ojenebe, Aya and Opa) were selected from the villages in the LGA. Personal interview with respondents was done using semi-structured questionnaire for data collection. Five charcoal producers and marketers each were selected in each village for data collection. Ten copies (10) of questionnaire were administered in each village (Table 1). The questionnaire was divided into sections. Section A was on demography of respondents, Section B, centered on charcoal production process. Section C addressed issues of socio – economics of charcoal production while Section D focused on environmental impact of charcoal production. A total number of fifty (50) copies of semi-structured questionnaire were used in Otukpo LGA.

Table 1: Administration of questionnaire in the study area.

S/No	Wards	No of villages	Target of respondents in each village	No. of questionnaires	Total no questionnaires
1	AdokaIcho	2	i. Charcoal producers	5	20
			ii. Charcoal marketers	5	
2	AdokaEhaje	3	i. Charcoal producers	5	30
			ii. Charcoal marketers	5	
			Total		**50**

Data Analysis

Data collected from the study were analyzed with one-way Analysis of Variance (ANOVA) with Duncan Multiple Range used as follow test where the is significant. Descriptive statistics such as tables and charts were used for result presentation.

RESULTS AND DISCUSSION

Demographic data of respondents in Adoka, Otukpo LGA

Table 2 shows the demographic information of the respondents involved in charcoal production and sales in Otukpo. The results revealed that 80% males and 20% females were involved in charcoal production and marketing. The respondents were mostly (58%) in the age class of 21 – 30 years, 26% in the age class of 31 – 40 years, while the least (8%) was in the class of 0 – 20. Information on educational level of the respondents shows that 6% had primary education, 58% secondary, 32 % tertiary, while 4% no formal education. Respondents were civil servant (6%), farmers (40%), traders (28%) while other occupations accounted for 26%. Data on marital status of the respondents show that 54% of charcoal producers were single, 44% were married while 2% were widow. The higher number of males in charcoal production in the area could be as a result of extraneous energy and hazard encounter in the business which could only be subsumed by the masculine nature of males. This agrees with the finding several authors (Isah *et al.,* 2021; Ekhuemelo *et al.,* 2017; Ekhuemelo *et al.,* 2018; Adeniji, *et al*., 2015) w reported who reported more males than females in charcoal production.

Most of respondents in Otukpo LGA was in age class of 21 -30 years which were mainly youths. This again is similar to the finding of (Adeniji, *et al*., 2015) who reported ages of charcoal producers in their study to range between 17 – 30 and 20 – 39 years, respectively. This might be due to unemployment and energetic nature of youth folks. Most Nigerian youths are very active to seeking opportunities in every field of endeavour to earn a living for themselves. The level of education of respondents in charcoal business was secondary school who were typically rural married farmers. This agrees with the finding of Adeniji (2015) on the charcoal production and producers in Borgu LGA of Niger State, Nigeria. It was also observed higher institution graduates were second highest in charcoal production. This might be due the high rate of unemployment among tertiary education graduates in Nigeria. Many graduates in Nigeria now seek for means of livelihoods after the National Youth Service Corps (NYSC).

Preferred wood Species for Charcoal Production in Otukpo LGA

Table 3 shows wood species used for charcoal production in the study areas. *Afzelia africana, Burkea africana, Pterocarpus erinaceus, Prosopis africana,* and *Khaya senegalensis* species were the common wood used for charcoal production in both Adoka-Icho and Adoka-Ehaje in Otukpo LGA. However,

Erythropleum suaveolens and *Milicia excelsa* were common to Adoka-Ehaje (Opa, Onipi and Aya) whereas in Adoka-Icho, *Lophira lanceolata, and Vitellaria paradoxa* were found to be common. The most preferred wood species for charcoal product in Adoka-Icho and Adoka-Ehaje Wards of Otukpo LGA was *Prosopis africana.* This finding agrees with the study of Adeyiji *et al*., (2015); who reported that *P. Africana* was the most preferred tree species used by charcoal producers in Borgu Local Government of Niger State. The finding also agrees with the study of Ekhuemelo *et al*., (2019) who reported *P. africana* as most preferred tree species used by charcoal producers in Guma and Makurdi LGA of Benue State, Nigeria

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Table 2: Demographic information of the respondent in Otukpo LGA of Benue State

Variables	Otukpo LGA	
	Frequency	Percentage (%)
Sex		
Male	40	80
Female	10	20
Total	**50**	**100**
Age		
0 – 20	4	8
21 – 30	29	58
31 – 40	13	26
Total	50	100
Level of Education		
Primary	3	6
Secondary	29	58
Tertiary	16	32
No formal	2	4
Total	**50**	**100**
Occupation		
Civil occupation	3	6
Farmer	20	40
Trading	14	28
Others	13	26
Total	50	100
Marital status		
Married	22	44
Unmarried	27	54
Window	1	2
Total	50	100

Table 3: Wood species used for charcoal production in Otukpo LGA

S/No	Council Ward	Names of village	Family	Scientific Name	Common Name	Local Name	
						Idoma	Tiv
			Mimosoideae	*Prosopis africana*	Iron wood	Okpehe	Gbaaye
			Fabacea	*Pterocarpus erinaceous*	Bar wood	Ache	Gangi
			Fabacea	*Parkiabiglobosa*	Locust bean	Ugba	Nune
			Fabacea	*Afzeliaafricana*	African mahogany	Ukpo	Yiase
		1. Onipi	Caesalphiniace	*Burkeaafricana*	White syrnya	Okachi	Gbaghongom
			Moraceae	*Miliciaexcelsa*	Iroko	Uloko	Leke
			Erythroxylaceae	*Erythropleumsuaveolens*	Ordeal tree	Eney	Kor
			Sapotaceae	*Viltellariaparadoxa*	Shea butter tree	Okume	Ichamegh
			Miliaceae	*Khaya senegalensis*	Mahogany	Opi	Haa
			Moraceae	*Milicia excels*	Iroko	Uloko	Leke
			Mimosoideae	*Prosopis africana*	Iron wood	Okpehe	Gyaaye
			Fabacea	*Pterocarpus erinaceus*	Barwood	Ache	Gangi
	Adoka-Ehaje	2. Aya	Fabacea	*Afzeliaafricana*	African mahogany	Ukpo	Yiase
1.			Miliaceae	*Khaya senegalensis*	Mahogany	Opi	Haa
			Caesalphiniace	*Burkeaafricana*	White syrnya	Okachi	Gbaghongom
			Ochnaceae	*Lophiralanceolata*	Darf red ironwood	Okopi	Hwarkera
			Erythroxylaceae	*Erythropleumsuaveolens*	Ordeal tree	Eney	Kor
			Caesalphiniace	*Burkeaafricana*	White syrnya	Okachi	Gbaghongom
			Mimosoideae	*Prosopis africana*	Iron wood	Okpehe	Gbaaye
			Fabacea	*Pterocarpus erinaceus*	Barwood	Ache	Gangi
			Fabacea	*Afzeliaafricana*	African mahogany	Ukpo	Yiase
		3. Opa	Fabacea	*Parkiabiglobosa*	Locust bean	Ugba	Nune
			Miliaceae	*Khaya senegalensis*	Mahogany	Opi	Haa
			Anacardiaceae	*Magniferaindica*	Mango	Ajah	Mango
			Erythroxylaceae	*Erythropleumsuaveolens*	Ordeal tree	Eney	Kor
			Moraceae	*Milicia excels*	Iroko	Uloko	Leke
			Ochnaceae	*Lophiralanceolata*	Darf red ironwood	Okopi	Hwarkera
			Mimosoideae	*Prosopis africana*	Iron wood	Okpehe	Gbaaye
			Fabacea	*Pterocarpus erinaceous*	Barwood	Ache	Gangi
		4. Adoka Centre	Fabacea	*Afzeliaafricana*	African mahogany	Ukpo	Yiase
			Fabacea	*Parkiabiglobosa*	Locust bean	Ugba	Nune
			Caesalphiniace	*Burkeaafricana*	White syrnya	Okachi	Gbaghongom
			Miliaceae	*Khaya senegalensis*	Mahogany	Opi	Haa
			Caesalphiniace	*Burkeaafricana*	White syrnya	Okachi	Gbaghongom
2.	Adoka-Icho		Mimosoideae	*Prosopis africana*	Iron wood	Okpehe	Gbaaye
			Fabacea	*Pterocarpus erinaceus*	Barwood	Ache	Gangi
			Fabacea	*Afzeliaafricana*	African mahogany	Ukpo	Yaise
		5. Ojenebe	Ochnaceae	*Lophiralanceolata*	Darf red ironwood	Okopi	Hwarkera
			Moraceae	*Milicia excels*	Iroko	Uloko	Leke
			Miliaceae	*Khaya senegalensis*	Mahogany	Opi	Haa
			Anacardiaceae	*Magniferaindica*	Mango	Ajah	Mango
			Erythroxylaceae	*Erythropleumsuaveolens*	Ordeal tree	Eney	Kor
			Sapotaceae	*Viltellariaparadoxa*	Shea butter tree	Okume	Ichamegh

Ranking of most preferred wood species for charcoal production in Otukpo LGA

Table 4 records ranking of preferred wood species used for charcoal production in Adoka-Ehaje and Adoka-Ichoin Otukpo LGA. *Prosopis africana* was the most preferred wood species used in charcoal production in both Adoka-Ehaje (32.47%) and Adoka-Icho (40.91%) Council Wards. *Khaya senegalensis* (18.18%) and *Pterocarpus erinaceous* (25.00%) species were also commonly used for charcoal production in Adoka-Ehaje and Adoka-Icho, respectively. The least preferred wood species in both Council wards were *Lophira lanceolate* (9.09%) in Adoka-Ehaje and *Erythrophleum suaveolens* (7.79%) in Adoka-Icho.

Table 4: Ranking of preferred tree species for charcoal production in Otukpo LGA

S/No	Wards	Scientific names	F	%	Rank	Other uses
1	AdokaEhaje	*Prosopis africana*	25	32.47	1	Firewood, mortar, construction of local bridge, medicinal purposes and fruit for soup making.
		Khaya senegalensis	14	18.18	2	Firewood, construction of local bridge, roofing of houses, fire wood, and medicinal Purpose
		Pterocarpus erinaceous	13	16.88	3	Furniture, roofing of houses,
		Burkeaafricana	11	14.29	4	Firewood, local medicine
		Miliciaexcelsa	8	10.39	5	Firewood, roofing of houses
		Erythropleumsuaveolens	6	7.79	6	Canoe making, medicinal purpose and local bridge construction
		Total	**77**	**100**	21	-
2	AdokaIcho	*Prosopis africana*	18	40.91	1	Firewood, mortar, construction of local bridge, medicinal purposes and fruit for soup making.
		Pterocarpus erinaceous	11	25.00	2	Furniture making, firewood and construction of local bridge
		Khaya senegalensis	6	13.64	3	Firewood, construction of local bridge, roofing of houses, fire wood, and medicinal purposes
		Afzeliaafricana	5	11.36	4	Seed for making food, construction of local bridge.
		Lophiralanceolata	4	9.09	5	-
		Total	44	100	15	-

Number of trees felled per production and duration of charcoal production process

Table 5 shows number of trees felled and duration of charcoal production process in the study area. In Adoka-Icho Council Ward, 23 trees (45.1%) were felled per charcoal production in Adoka center while it was 28 trees (54.9%) in Ojenebe. The results further show that within a week, a total of 150 trees week felled for charcoal production. In Adoka-Ehaje Council Ward, 27 trees (33.75%) were felled per production in Opa and Aya, respectively while in Onipi, it was 26 trees (32.5%). In a week, a total of 68 trees were felled for charcoal production in Adoka-Ehaje. The duration of charcoal production process ranged from 7-14 days while dry season was the most preferable period for charcoal production in the study area. Adebayo *et al.*, (2019) reported that 93.8% of respondents in selected agrarian communities of Oyo State strongly accepted charcoal production as one of the primary causes of deforestation. Adejumobi and Eniola, (2011) also reported 89.5% of the respondents in Oke-Ogun area who that charcoal production result to increase in tree felling. Adebayo *et al.*, (2019) observed that because of the high influx in charcoal business, the rate of deforestation would continuously increase in Nigeria

Table 5: Number of trees felled per production/duration of charcoal production process

Wards	Village	No. of logs felled per production		Number of trees per week		Duration of charcoal production process (burning)	Season for the production
		F	%	F	%		
Adoka-Icho	Adoka center	23	45.1	5	47.06	1 – 7 days	Dry season
	Ojenebe	28	54.9	36	52.94	-	Dry season
	Total	**51**	**100**	**68**	**100**		
Adoka-Ehaje	Opa	27	33.75	47	31.33	-	Raining and dry season
	Aya	27	33.75	41	27.33	-	Dry season
	Onipi	26	32.5	62	41.32	-	Dry season
	Total	**80**	**100**	**150**	**100**		

Earnings from charcoal production in Otukpo LGA

Table 6 presents perceived monthly earnings from charcoal production in Otukpo LGA. The result reveals that majority (29.63%) of charcoal producer-earned above ₦300,000 monthly in Adoka-Ehaje whereas in Adoka-Icho, 56.25% earned between ₦201,000 and ₦250,000 monthly. The least earnings were between ₦ 151,000 – ₦200,000 (6.25%) in Adoka-Icho and 3.70% charcoal producers in Adoka-Ehaje respectively. This study reveals that charcoal producers in Otukpo earned so much from their businesses and were about to meet family demands and needs. This finding agrees with Tunde *et al.,* 2013 who reported that charcoal production has important aspect of the positive impact on lives of producers since income realized was always used to improve their well-being and hence alleviate their poverty situation. It was further observed that charcoal producers in the study area used their earnings majorly for feeding and clothing. This agree with the study of Tunde *et al.,* (2013) who reported that charcoal producers in Asa LGA, Kwara State claimed they used the income they realized from charcoal production for purchase of food items.

Table 6: Perceived monthly earnings from charcoal production in Otukpo LGA

Market Channels of Charcoal Sales in Otukpo LGA

Table 7 shows the results of market channels of charcoal sales in Adoka-Icho and Adoka-Ehaje. Results from Adoka-Icho show that, 39.53% of respondents reported presence of market for their products. The types of market were wholesale (38.24%) and retail (43.75%). However, 55.55% of charcoal products were sold within Benue State while 36.58% were sold to other States. In Adoka-Ehaje, 57.15% of respondents asserted that there was no market for their products. The types of market reported were wholesale (61.77%) and retail (56.25%). It was noted that 44.44% of charcoal products were sold within Benue State whereas 63.41% were sold to other States.

Table 7: Market channels of charcoal production in Otukpo LGA

S/No.	Wards	Presence of market				Types of market				Market channel			
		Yes		No		Wholesaler		Retailer		Benue State		Other States	
		F	%	F	%	F	%	F	%	F	%	F	%
1	Adokaicho	17	39.53	3	42.86	13	38.24	7	43.75	5	55.55	15	36.58
2	Adokaehaje	26	60.46	4	57.15	21	61.77	9	56.25	4	44.44	26	63.41
	Total	43	100	7	100	34	100	16	100	9	100	41	100

Respondents efforts in tree planting in Adoka

Table 8 shows respondents' efforts in tree planting exercise in Otukpo. In Adoka-Icho, there was high percentage of forest plantation in Ojenebe, and Adoka Centre, with 55.55%, and 44.44% mainly through forest plantation. Whereas in Adoka-Ehaje, there was high percentage of forest plantation in Opa and Onipi (54.54%, and 27.27) respectively. The result indicates high level of forest plantation practices by respondents in study area. This result also indicates that respondents in the study area were making effort in growing trees of which forest plantation was highest practice of reforestation. This effort by the respondent may be because they were aware of the future danger post to their business if tree cut were not replaced.

Number of charcoal producers in each villages/community in Adoka

In Adoka-Ehaje Ward had higher number (287) of charcoal producers compared to Adoka-Icho (137). However, Adoka Centre and Ojenebe villages in AdokaIcho had 41.61% and 58.39% while in Adoka-Ehaje, Opa, Aya and Onipi villages had 41.30%, 23.91% and 34.79% charcoal producers respectively (Table 9). There is a significant difference among the means of charcoal producers in Opa village compare to the rest villages.

Table 8: Respondents effort in tree planting in Otukpo Local Government

S/No.	Wards	Villages	Replanting methods					
			Forest plantation		Agroforestry		Home garden	
			F	%	F	%	F	%
1	AdokaIcho	Adokacentre	4	44.44	4	40	3	75
		Ojenebi	5	55.55	6	60	1	25
Total			9	100	10	100	4	100
2	AdokaEhaje	Opa	6	54.54	3	27.27	4	50
		Onipi	3	27.27	5	45.45	1	12.5
		Aya	2	18.18	3	27.27	3	37.5
Total			11	100	11	100	8	100

Table 9: Number of charcoal producers in each village/community in Otukpo LGA

S/No.	Wards	Villages	Number of producers in each village		N	Mean number of charcoal producers Mean ± SD
			F	%		
	AdokaIcho	Adoka centre	57	41.61	10	8.50 ±5.072
		Ojenebe	80	58.39	10	8.00 ±2.667
	AdokaEhaje	Opa	152	41.30	10	15.30±6.516
		Aya	55	23.91	10	5.50 ±2.170
		Onipi	80	34.79	10	8.00 ±2.667
		Total	424			
		Df				4
		F stat				11.450
		p. value				0.000

Benefits from Charcoal Production in the Study Area

In Adoka Ehaje, the highest percentage earnings (44.8%) were used for feeding and clothing, followed by building of houses and payment of school fees with 24.14%, respectively. While in Adoka-Icho, payment of school fees, followed by feeding and clothing then building of houses (35%, 30% and 25%) were observed as livelihoods of the villages from charcoal production. The result indicates that the charcoal producers used high percent of their earning for feeding and clothing (Figure 3). Okode *et al.*, (2019) reported that income from sales of charcoal was beneficial to rural dwellers in Kenya in providing health services, daily savings, building constructional materials and Payment of pay school fees of their children.

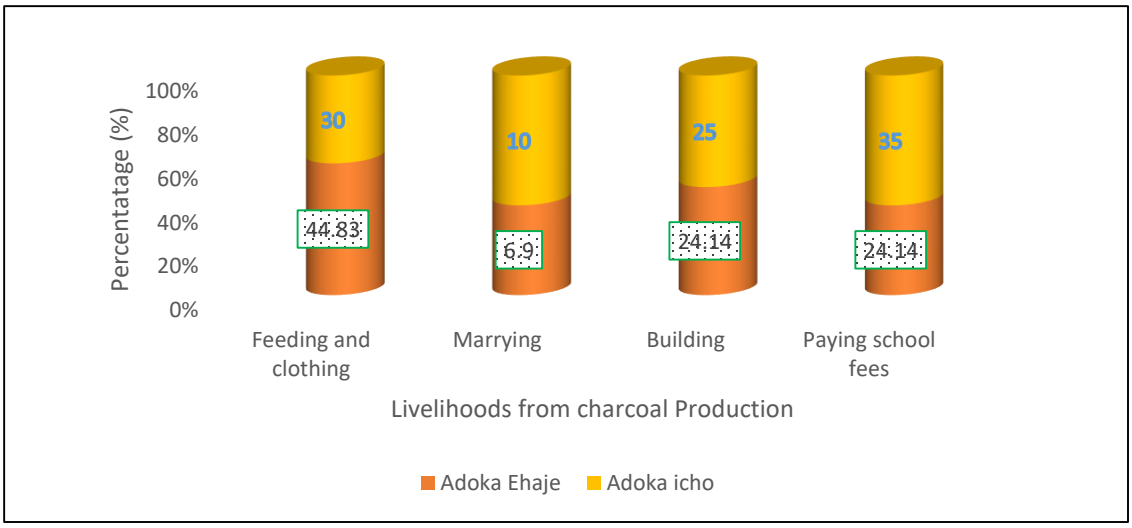
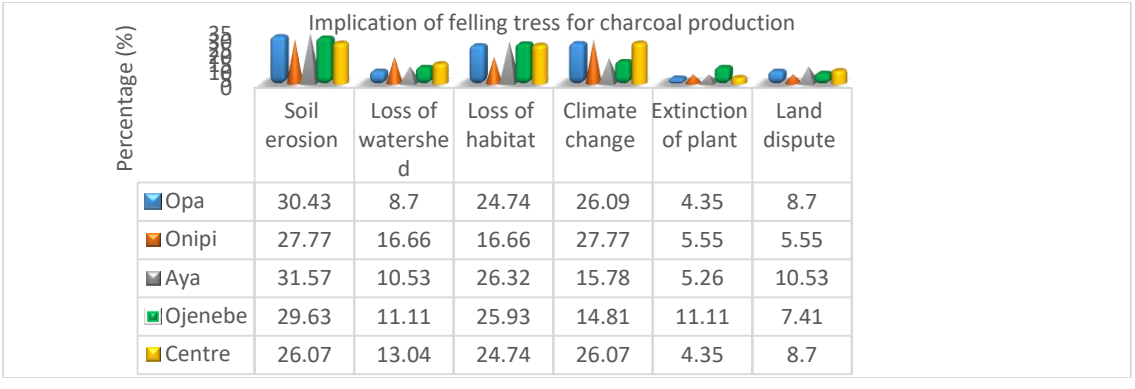


Figure 3: Achievement from charcoal production business in Adoka-Ehaje and Adoka-Icho in Otukpo LGA

Impact of charcoal production in the study area

Most respondents claimed that soil erosion was the major impact of charcoal production in Aya, Apa, Ojenebe and Onipi (31.57%, 30.43%, 29.63%, 27.77% and 26.07%) communities, respectively in Adoka. Other perceived environmental impacts of charcoal production include climate change (27.77%), loss of habitat (26.32%), loss of watershed (16.66%), extinction of plants (11.11%) and land dispute (10.53%), respectively (Figure 4). Plate 1 transport of logs for charcoal processing, interview with producer in Aya in and charcoal production sites. Plate 2 shows bags of charcoal in Ojenebe of Otukpo ready to be sale, while Plate 4 and revealed pilled of wood prepared for production in Onipi in Otukpo LGA. Plate 6: Charcoal production site at Opa in Adoka-Ehaje ward of Otukpo LGA.

In this study, respondents were aware that charcoal production has adverse environmental impact with soil erosion accounting the highest. Ogundele *et al*, (2011) reported that charcoal production influence soil properties. In their study, there was increase in calcium, sodium, phosphorus and soil pH while there was decrease in potassium and magnesium. Also, Oguntunde *et al.* (2004) in Ghana recorded a substantial increase in soil pH, base saturation, electrical conductivity, exchangeable Ca, Mg, K, Na, and available P in the soil at a charcoal production sites in relation to adjacent soil. This finding disagrees with a study carried out by Chidumayo and Gumbo (2013) that emission of greenhouse gases from charcoal production in the tropical ecosystem. This is also in agreement with Tunde *et al.*, (2013) that has different adverse impacts on the environment. Land degradation is another well – known problem resulting from deforestation activities for whatever purpose including charcoal production. (Jamala *et al*, 2013).



	Soil erosion	Loss of watershed	Loss of habitat	Climate change	Extinction of plant	Land dispute
Opa	30.43	8.7	24.74	26.09	4.35	8.7
Onipi	27.77	16.66	16.66	27.77	5.55	5.55
Aya	31.57	10.53	26.32	15.78	5.26	10.53
Ojenebe	29.63	11.11	25.93	14.81	11.11	7.41
Centre	26.07	13.04	24.74	26.07	4.35	8.7

Figure 4: Environmental Implications of tree felling for charcoal production in Otukpo LGA

Plate 1:
A: Transport of logs for charcoal processing in Opa in Otukpo LGA
B: Charcoal production site at Opa in AdokaEhaje ward of otukpo LGA
C: Removal of charcoal from earth kiln

Plate 2:
D: Interviewing charcoal producer at Aya village
E: Bags of charcoal in Ojenebe Village in Otukpo LGA ready for sale

CONCLUSION

There were more males than females in charcoal production business in the study area. The males were predominantly youth. High population rural people are involved in charcoal production in the Otukpo LGA. This has led to massive deforestation without corresponding efforts in replanting felled trees. The most preferred wood species was *Prosopis africana*. This species is seriously threatened because of its numerous uses. Charcoal production was observed to improve socio – economic benefits to people of Otukpo LGA mostly by feeding families and clothing, paying of school fees and building of houses as source of employment. Charcoal production in the rural areas of Nigeria is increasing on daily basis as a result of increase in the price of domestic fuel such as oil and gas. Charcoal production is one of the primary causes of deforestation leading to land degradation in areas

involved in the business. The business is associated with the felling of both mature and nearly-mature trees. Deforestation is a serious problem leading to global warming; therefore, the business World must wake up to, especially to mitigate the effect of global climatic change.

RECOMMENDATIONS

i. There is need for an alternative source of energy in order to reduce the demand on charcoal.
ii. There is need for Government to encourage sustainable forest management in order to curb indiscriminate felling of trees.
iii. As much as possible, all forest stakeholders in Benue state should ensure the conservation of *Prosopis africana* to avoid its extinction due to its massive exploitation.
iv. Alternative means of livelihood should be provided by Government for charcoal producers in Otukpo LGA to discourage them from charcoal production because of its associated deforestation.

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