



Effect of charcoal production on livelihoods and environment in agrarian communities of Adoka District, Benue State, Nigeria

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Abstract

Effect of charcoal production on livelihoods and environment in Idoka District, Benue State, Nigeria was assessed. Charcoal production communities were selected randomly and visited. Multi-stage sampling method was employed to select targeted respondents and interviewed with Google Form semi-structured questionnaire. Three Council Wards and six communities were chosen for the study. A total of 60 respondents were interviewed. Respondents were mostly married (61.7%) males (98.3%) and Christians (81.7%). Majority of respondents (36.7%) were in 21 – 30 years age class, had tertiary education (40%) and were farmers (46.6%). Every respondent (100%) agreed that charcoal was produced in Adoka District while 51.7% indicated 21 to 30 individuals were involved in the charcoal production. *Prosopis africana* (71.7%), *Khaya senegalensis* (21.7%), *Magnifera indica* (5.0%) and *Lophira lanceolate* (1.7%) were utilized and *P. africana* (88.3%) was the most preferred. *Prosopis africana* also used for: firewood (100%), condiment (66.7%), timber (33.3%), medicine (20%) and, food and tools making (16.7%). Most respondents (95%) felled 1 - 5 trees per charcoal production while they daily (98.3%) engaged in the business. Respondents (73.3%) earned N5,000 daily and 66.7% earned above N30,000 monthly; and invested earnings on trading (60%), farming (13.3%), unnamed businesses (18.3%), purchase of motorcycle/vehicle (45%), building of houses (30%), payment of school fees (21.7%) and marrying wife(es) 1.7%. Perceived environmental impact of charcoal production were air pollution (58.3%), soil infertility/degradation (36.7), deforestation (20%) and poor yield of agricultural crops (16.7%). Respondents were exposed to fire burn (70%), leg injury 46.7%, hand injury (30%), eye related problems (11.7%) and wait pain (3.3%) while they used protective materials like boot (88.3%), eye goggles (43.3%) and hand gloves (38.3%) during charcoal production exercise. In conclusion, despite the benefits of charcoal production in Adoka District, the exercise has had adverse impacts on the environment.

Keywords: Charcoal, environment, livelihood, wood species, Idoka.

Introduction

The most significant base of renewable energy in the history of human on earth is the forest¹. In many rural and urban communities in Nigeria, most Africa countries and in the world as a whole, fuel wood, charcoal and other forest bio fuel still are being used for heating and cooking as forms the traditional forms of forest biofuel². Forest trees and wood have been an immense importance to man for various purposes. Prominent wood is a very useful raw material known throughout the world for its benefits such as fuel wood, charcoal production and sale, building and construction materials, furniture, bridge making especially in rural places, tools and arts making among others. Charcoal is the dark grey colour residue containing carbon and produced from slow process of heating wood in the absence of oxygen is called 'Pyrolysis'. It is a mixed form of carbon containing ash in wide-ranging degree contingent on the biomass used. Charcoal is a significant source of domestic fuel in many households. Outside wood, charcoal is produced from numerous organic materials like rice husks, bones coconut shells, and many agricultural remain like maize husk and stem. Several studies have shown that several hardwood species like

Acacia spp., *Mangroves* spp. and *Prosopis* spp. were mostly preferred and utilized for charcoal production since they possess high density and heating capacity³.

Nigeria is currently facing challenges of high cost of kerosene, diesel, fuel and electricity. As a result, renewable and bioenergy like charcoal has become of paramount importance on daily bases as domestic energy used in rural and urban settings. In similar development, Zulu and Richardson⁴ reported rural communities of developing countries are dependent on wood fuel, charcoal, briquette and dried dung for their energy utilization.

Wood fuel energy is a remarkable household energy demand which on upsurge with the rising cost of petroleum products and electricity in many countries. Nigeria with growing economic difficulties is witnessing many people and households finding it continuously tough to afford non-renewable fuels⁴. Kammen and Lew⁵ indicated that charcoal was the main energy basis for cooking, prominent base of revenue generation and environmental degradation in rural communities of many African States including Nigeria.

The charcoal business and trading has become a very profitable venture in Nigeria⁶. It involves retailers, wholesalers and suppliers because of the high cost and unavailability of the products. Uses of charcoal includes cooking, barbeque and heating and casting bronze and other metals. Food sellers and caterers who cook for large gatherings, some households use charcoal as alternative source of energy due to its availability and low cost compare to fossil fuel and electricity. Charcoal from wood can be produced and used throughout the year although it is generally recommended that the production and export ought to be carried in the dry season⁷.

Production and sale of charcoal has potentials in generating employment and livelihoods for rural poor and alleviating the challenges faced in meeting energy needs in Nigeria and in many Africa countries. Apart from charcoal production, forests provide variety of products and services which reliably contributes to the livelihoods of millions of people globally that live in or near tropical forests and savannahs⁸. It is therefore very important that tropical forests are protected to for sustainable use of its abundant products.

In 2010, Benue was reported to have 73.5kha of tree cover and stretching over 2.3% of her land area. Currently as at 2021, the State lost 853ha of tree cover which is comparable to 232kt of CO₂ emissions². This lost probably may be due to deforestation for various purposes one of which could be for charcoal making. Several studies have been carried out on the environmental impact of charcoal making and sales in Benue State^{9,10}. However, not much is known or documented on the charcoal production and sales activities in Adoka in Benue State. Therefore, this study was undertaken to assess the environmental and socio-economic impact of charcoal making in Adoka in Benue State.

Materials and methods

Study Area: This study was conducted in three council worlds in Adoka is situated at geographical coordinates of 7°27'0" North, 7°58'0" East in Oturkpo Benue, Nigeria. Adoko lies within the Savannah (Southern Guinea) with its distinguishing

coarse grasses and abundant species of dispersed trees. The constant clearance of the vegetation for agriculture and practice of bush fallowing practice led to the expansion of regrowth vegetation at several planes¹¹. The vegetation is lightly spread excluding the open shallow valleys where the vegetation is thicker. In addition to metropolitan in the three Council Wards in Adoka districts, they grow rice, yam, cassava, guinea corn and maize crops. Adoka is divided into three ward council Adoka Icho ward, Adoka district Ehaje Ward and Entekpa Council Ward. Adoka comprises of rich tree diversities like *Daniellia oliveri* *Vitellaria paradoxa*, *Irvingia gabonensis*, *Dacryode, edulis*, *Annona senegalensis*, *Afzelia africana*, *Ficus species*, *Parkia biglobosa*, *Prosopis africana*, *Acacia Species*, *Khaya senegalensis*, *Magniferaindica* and *Tamirandus indica* to mention but few¹². The major features of climate of Adoka are wet and dry season and it varies from year to year. The rainy season starts from April, continues to October or November, with the highest peak in August and September. The soil of the study area is usually ferruginous in nature dominated by clay, loamy and sandy. Figure-1 shows the map of Adoka.

Experimental Design and data collection technique: The technique used in this study to select villages involved in charcoal making in Adoka was Snowball sampling technique adopted Ekhuemelo *et al.*,⁹ for similar. The targeted respondents were charcoal marketers, farmers, villagers. Subsequently the identified villages where charcoal making was done were randomly selected and visited. Multi-stage Sampling Technique was employed to select respondents who were interviewed with Google Form semi-structured questionnaire. Three Council Wards selected were namely: Adoka-Icho, Adoka-Ehaje and Entekpa-Council while a total of six villages (Okpeje, Aune, Ugah, Olakpoga, and Umogidi) were chosen (Table-1). Ten respondents were interviewed on face-to-face interview approach. Google Form questionnaire was constructed such that formation on the demography of respondents, charcoal making process, effect of charcoal production on socio-economics of respondents, environmental and human hazard impact of charcoal making and safety precaution were elicited.

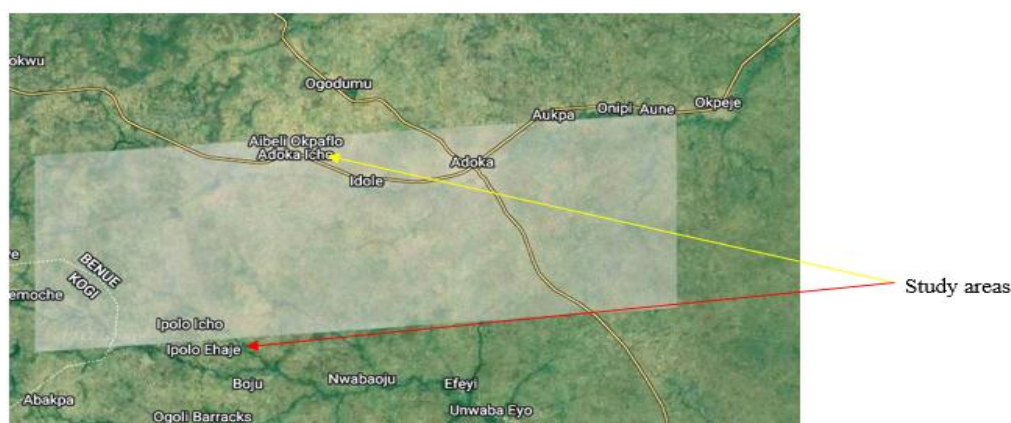


Figure-1: Google Map of Adoka, Benue State.

Data Analysis: Data collected from this study were showed in Charts and Tables

Results and discussion

Table-2 presents results of demographic information of the respondents involved in charcoal production and sales in Adoka. The results revealed that respondents were mostly married (61.7%) males (98.3%) and predominantly Christians (81.7%). Also, majority of respondents (36.7%) were in age class of between 21-30 years, had tertiary education (40%) and were farmers (46.6%).

In Figure-2, every respondent (100%) agreed that charcoal was produced in Adoka District while 51.7% agreed that 21-30 individuals were involved in the production (Figure-3). Respondents confirmed that only traditional method (100%) was employed in the production of charcoal in Adoka (Figure 4). Four wood species in the sequence of *Prosopis africana* (71.7%) > *Khaya senegalensis* (21.7%) > *Magnifera indica* (5.0%) > *Lophira lanceolate* (1.7%) were utilized for charcoal production in the area (Table-3). However, *P. africana* (88.3%) was mostly preferred wood species by respondents for charcoal making (Figure-5).

Table-1: Questionnaire administration procedure in six selected villages in Adoka.

Council Wards	Number of villages	Target of Respondents each village	Copies of questionnaire	Total copies of questionnaire	Resp. F (%)
Adoka-Icho	i. Uga	i. Producers of Charcoal ii. Marketers of charcoal	5 5	10	10(16.7)
Adoka-Ehaje	i. Aune ii. Okpje iii. Opa	i. Producers of Charcoal ii. Marketers of charcoal	5	30	10(16.7)
			5		10(16.7)
					10(16.7)
Entekpa-Council	i. Umogidi ii. Olakpoga	i. Producers of Charcoal ii. Marketers of charcoal	5	20	10(16.7)
			5		10(16.7)
					10(16.7)
Total	6			60	60(100)

Key: Quest. – Questionnaires; Resp. – respondent.

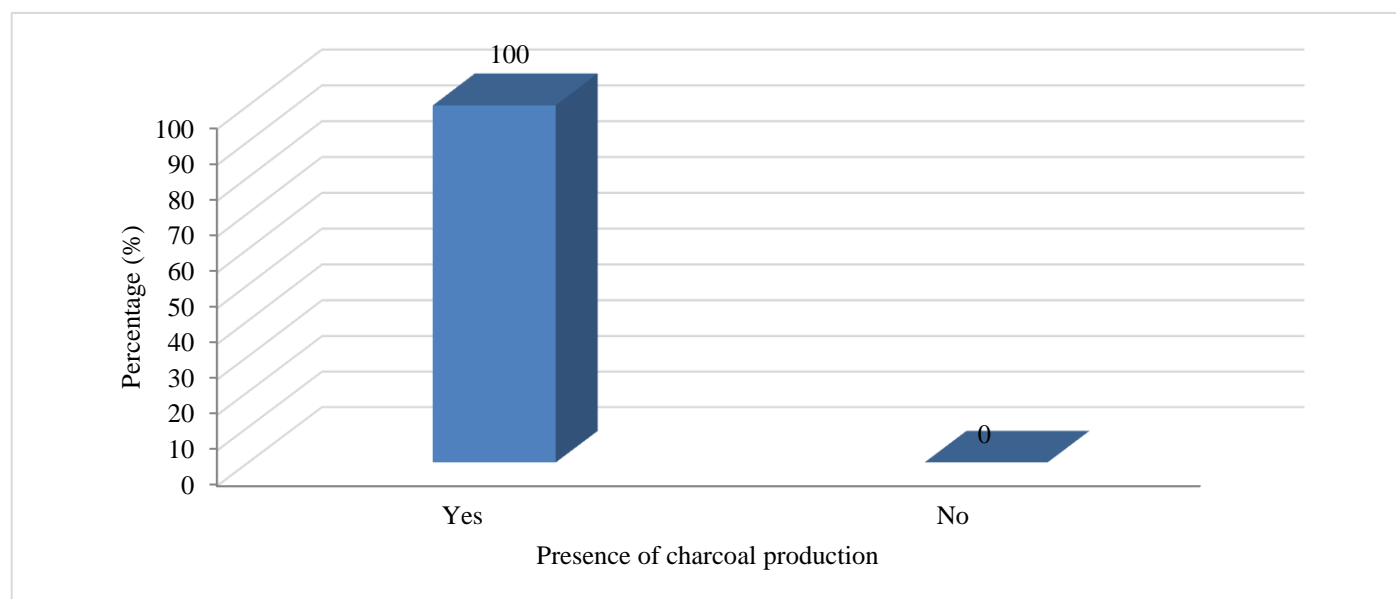


Figure-2: Presence of Charcoal making in Villages in Adoka district.

Table-2: Demographic information of the respondents in Adoka district.

Variables		Respondents	
		Frequency	%
Sex	Male	59	98.3
	Female	1	1.7
	Total	60	100
Marital status	Married	37	61.7
	Single	23	38.3
	Total	60	100
Religion	Christianity	55	81.7
	Traditional	5	8.3
	Total	60	100
Age	0 – 20	0	0
	21 – 30	22	36.7
	31 – 40	16	26.7
	41 – 50	18	30.0
	51 – 60	4	6.7
	Total	60	100
Level of Education	Primary	15	25
	Secondary	12	20
	Tertiary	24	40
	No formal	9	15
	Total	60	100
Occupation	Farming	28	46.6
	Trading	16	26.7
	Student	16	26.7
	Total	60	100

Table-3: Species of wood utilized for charcoal making by respondents in Adoka.

Family	Botanical Name	Common Name	Local Name		F	%
			Idoma Name	Tiv Name		
Mimosoideae	<i>Prosopis africana</i>	Iron wood	Okpehe	Gbaaye	43	71.7
Miliaceae	<i>Khaya senegalensis</i>	Mahogany	Opi	Haa	13	21.7
Anacardiaceae	<i>Magnifera indica</i>	Mango	Mango	Mangoro	3	5.0
Ochnaceae	<i>Lophira lanceolata</i>	Darf red ironwood	Okopi	Hwarkera	1	1.7

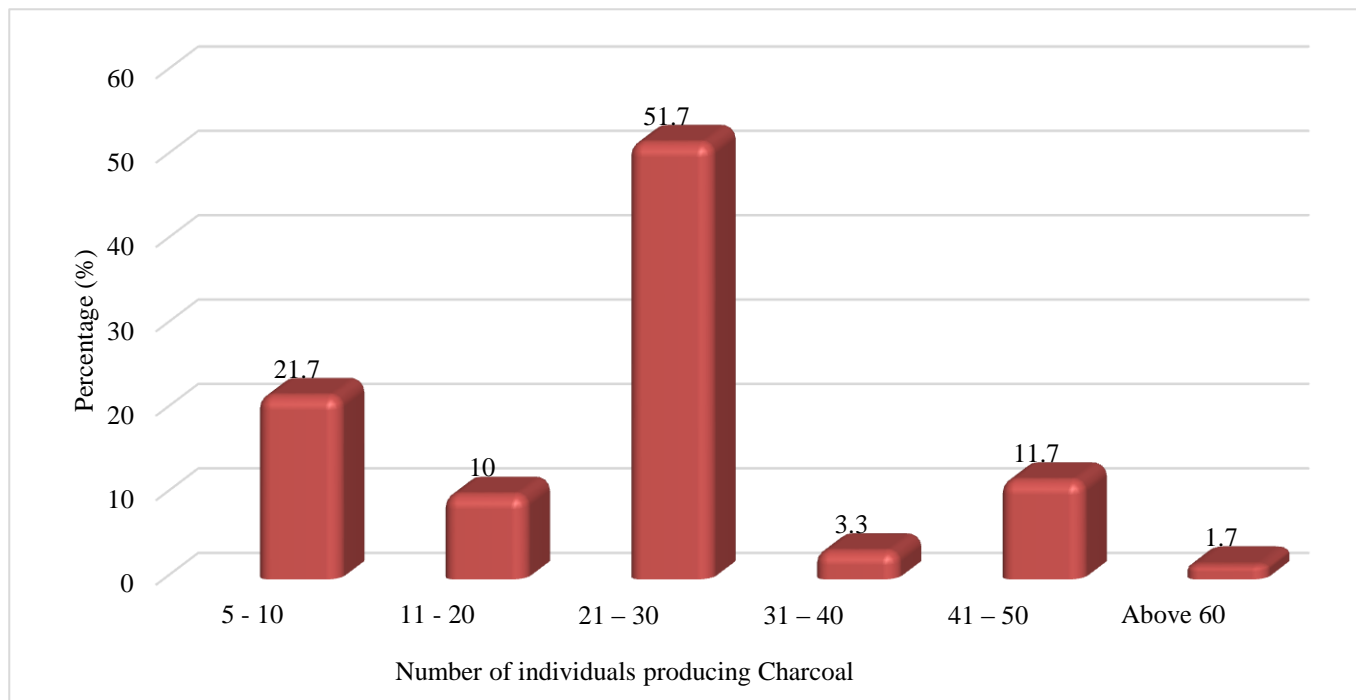


Figure-3: Number of people involved in producing charcoal in Adoka district.

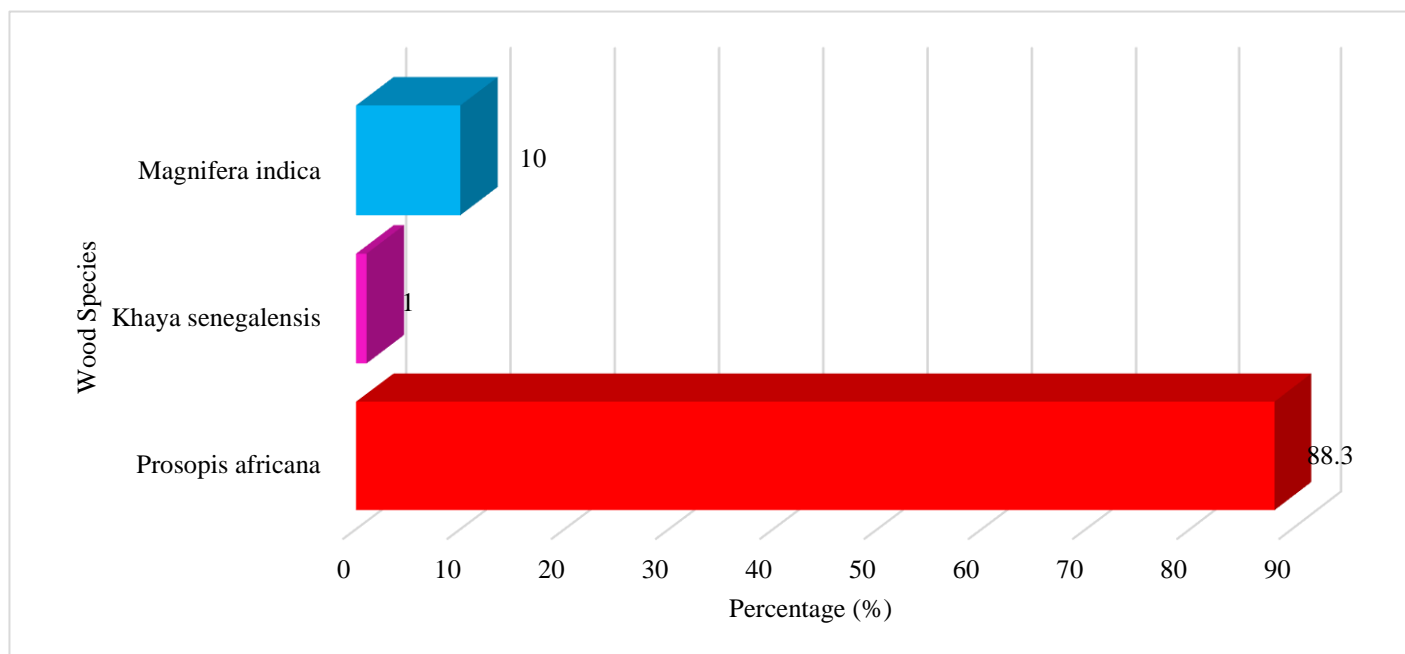


Figure-4: Preferred wood species used in charcoal making in Adoka.

Apart from charcoal making, respondents also used *Prosopis africana* for other purposes such as firewood (100%), condiment (66.7%), timber (33.3%), medicine (20%) and, food and tools making (16.7%) each (Figure-6).

Most respondents (95%) reportedly felled between 1 and 5 trees per charcoal making while they daily (98.3%) engaged in the

business (Figure-7). Respondents' daily and monthly earnings from charcoal are presented in Figure-8. Majority of them (73.3%) earned ₦5,000 daily while on monthly bases, 27.7% earned between ₦26,000 and ₦30,000; and 66.7% earned above ₦30,000. All respondents (100%) produced charcoal from using earth kiln.

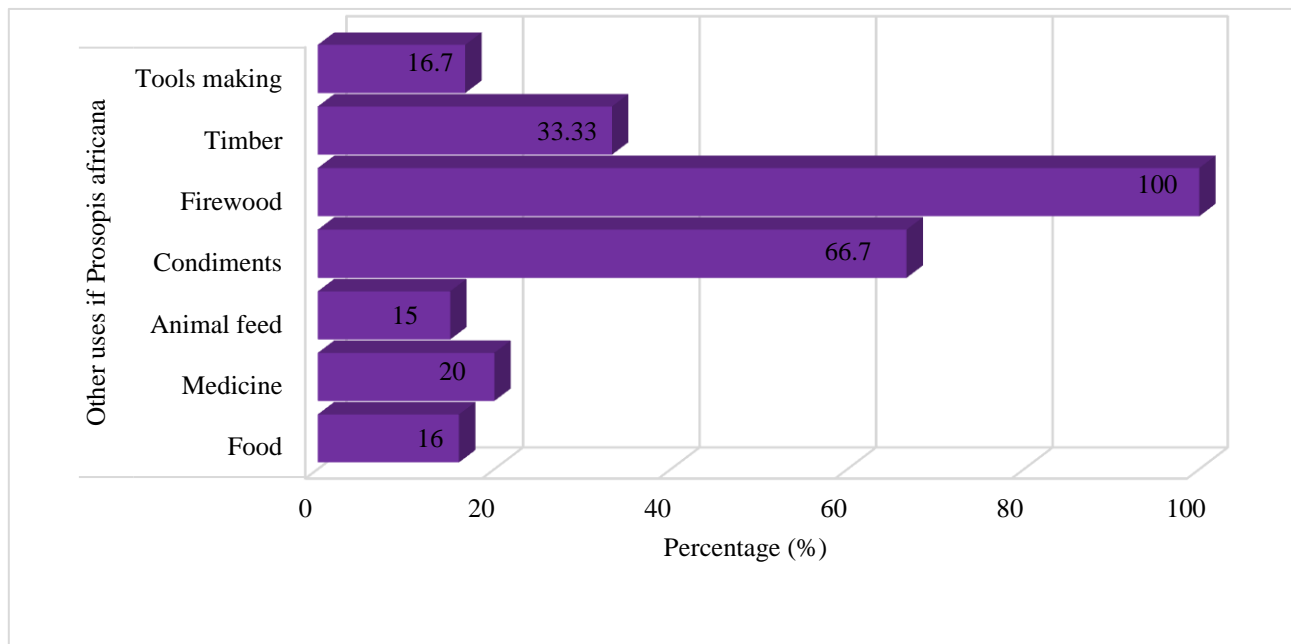


Figure-5: Other uses of *Prosopis africana* apart from charcoal.

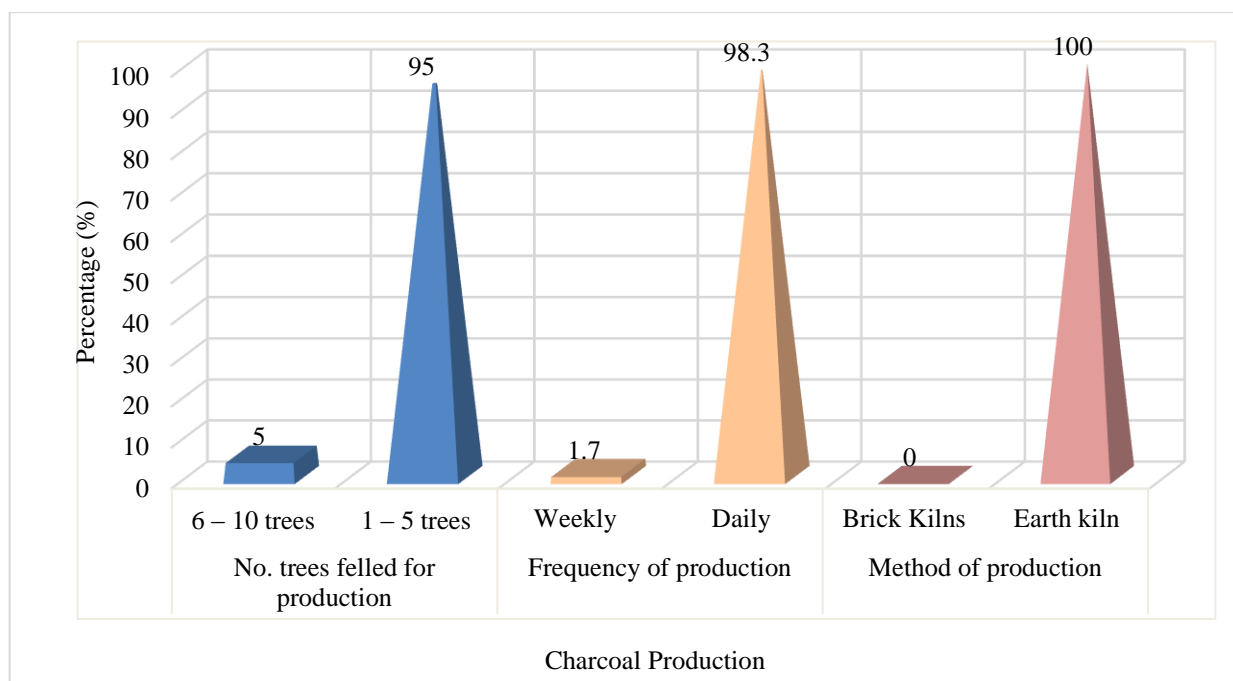


Figure-6: Frequency, method and average number of trees felled per production of charcoal.

Perceived environmental impact of charcoal production in Adoko as reported by respondents were air pollution (58.3%), soil infertility, degradation (36.7), deforestation (20%) and poor yield of agricultural crops (16.7%) (Figure-10). Activities involved in charcoal production was opined to cause injuries to respondents (Figure-11). These injuries include: fire burn (70%) as the highest injury sustained by respondents followed by leg injury 46.7%), hand injury (30%), eye related problems (11.7%)

and wait pain (3.3%). However, in Figure-12, respondents used protective materials like boot (88.3%), eye goggles (43.3%) and hand gloves (38.3%) during charcoal making exercise. Figure 13 shows logs of *Prosopis africana* and other wood species prepared for charcoal production. Figures-14 and 15 were bags of charcoal at Aune Adoka Ehaje ready for sale and earth kiln method use for charcoal production at Umogidi in Entelkpa Council Ward.

Respondents reportedly made some investments from earnings they realized from charcoal making and sales as presented in Figure-8. Many respondents (60%) invested in trading of other goods, farming (13.3%) and some unnamed businesses (18.3%).

Respondents also derived other benefits from charcoal enterprises which include: purchase of motorcycle/vehicle (45%), building of houses (30%), payment of school fees (21.7%) and marrying wife (es) 1.7% (Figure-9).

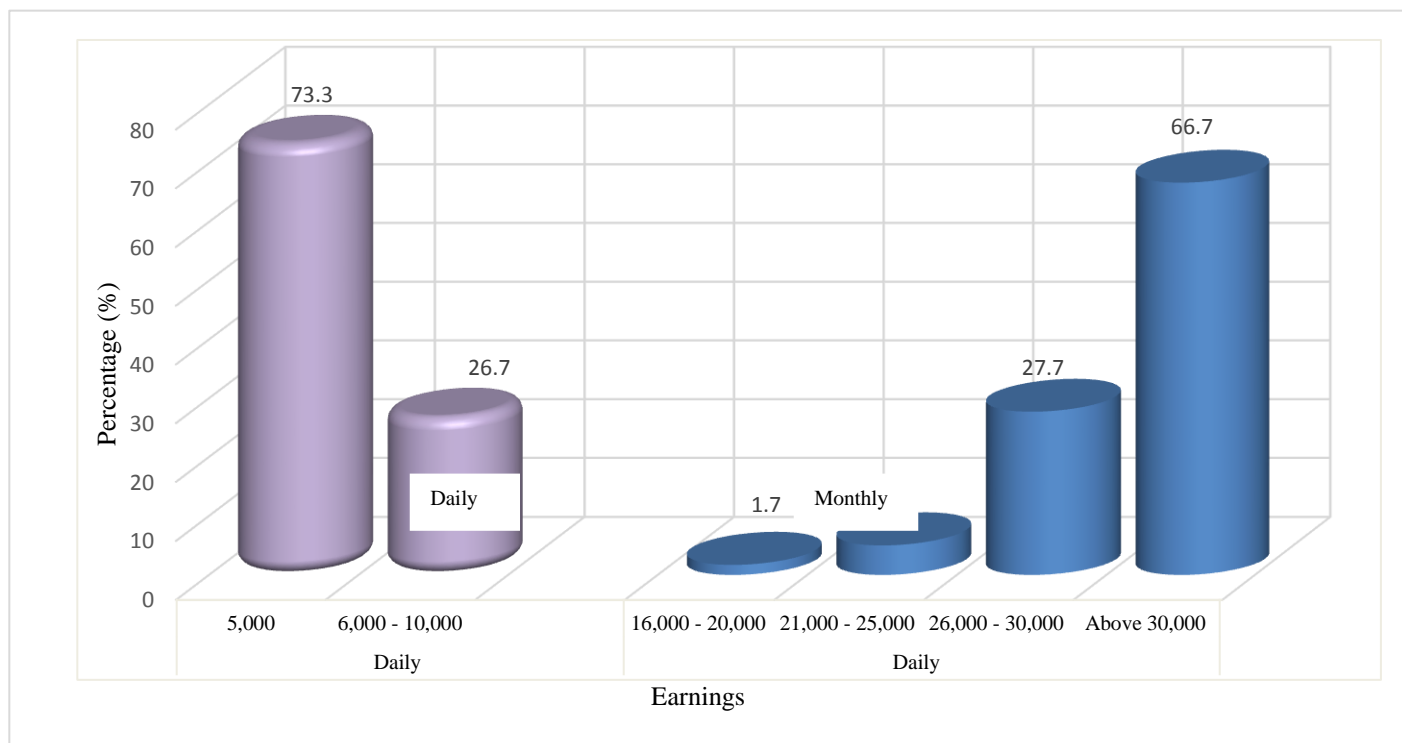


Figure-7: Respondents daily and monthly earnings from charcoal making. Key: Values in the figure is in Naira(₦).

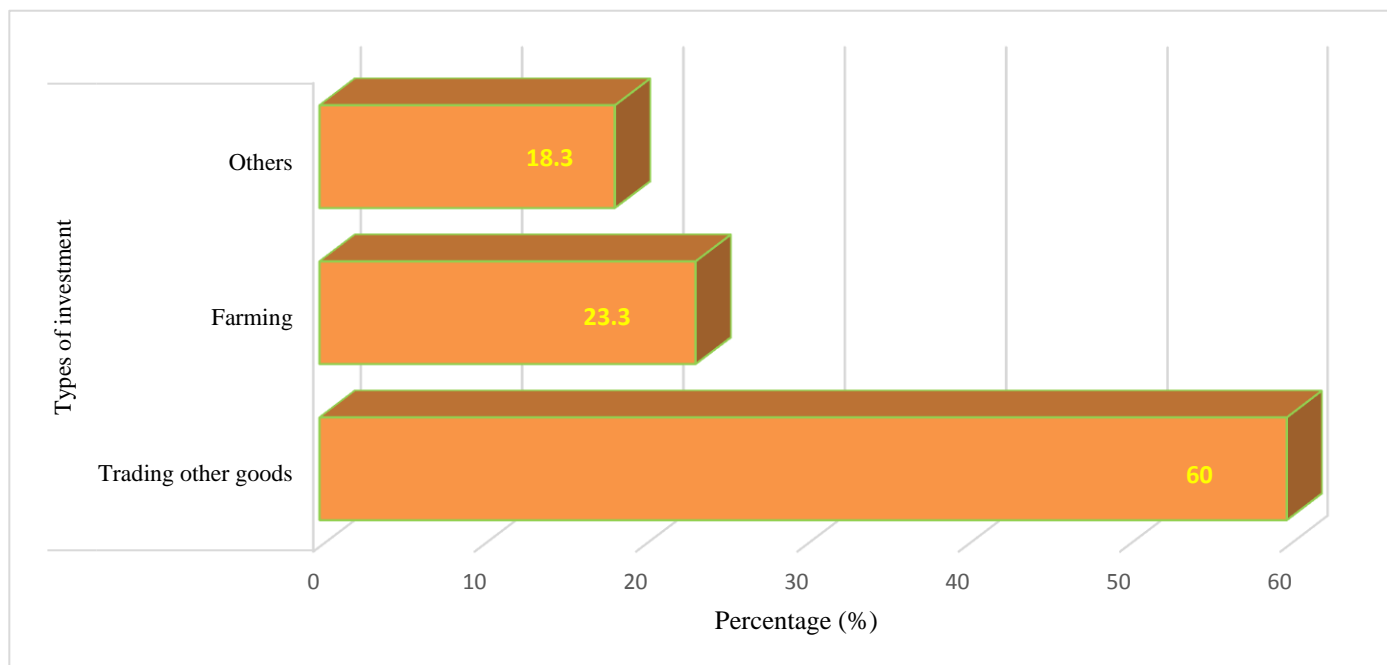


Figure 8: Types of investment made by respondents from charcoal business.

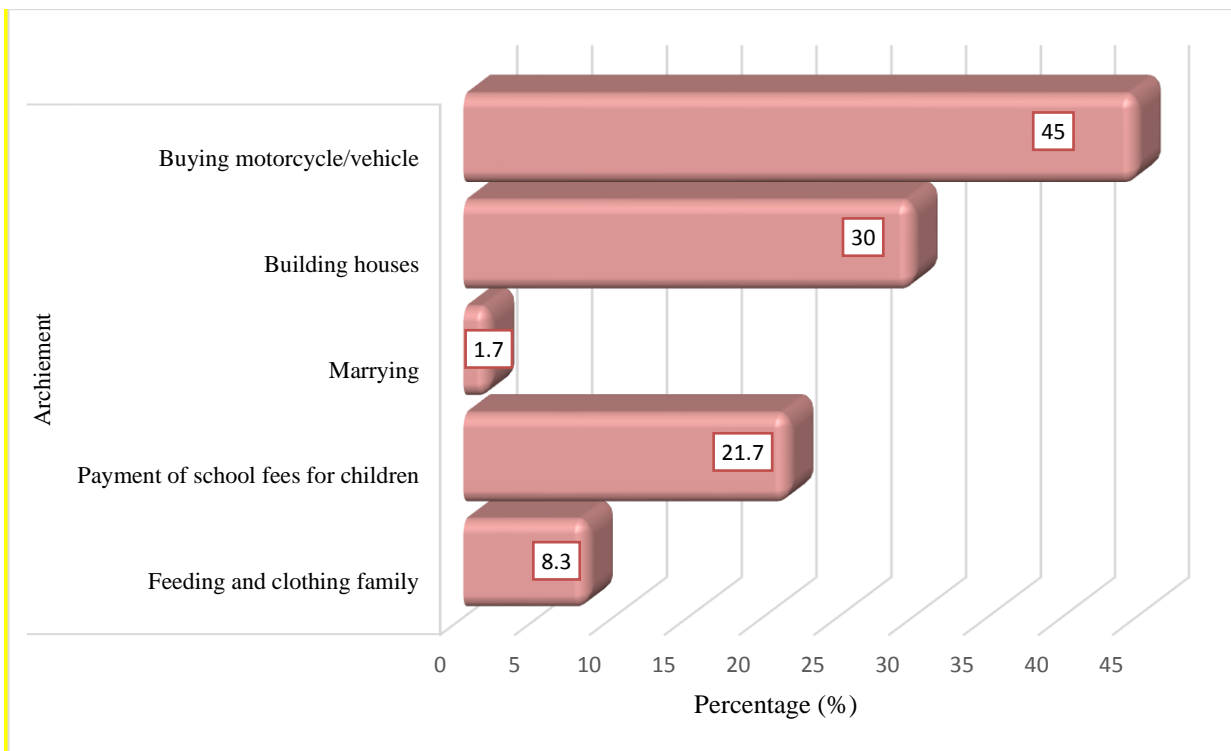


Figure-9: Type of Benefits from charcoal production by respondents.

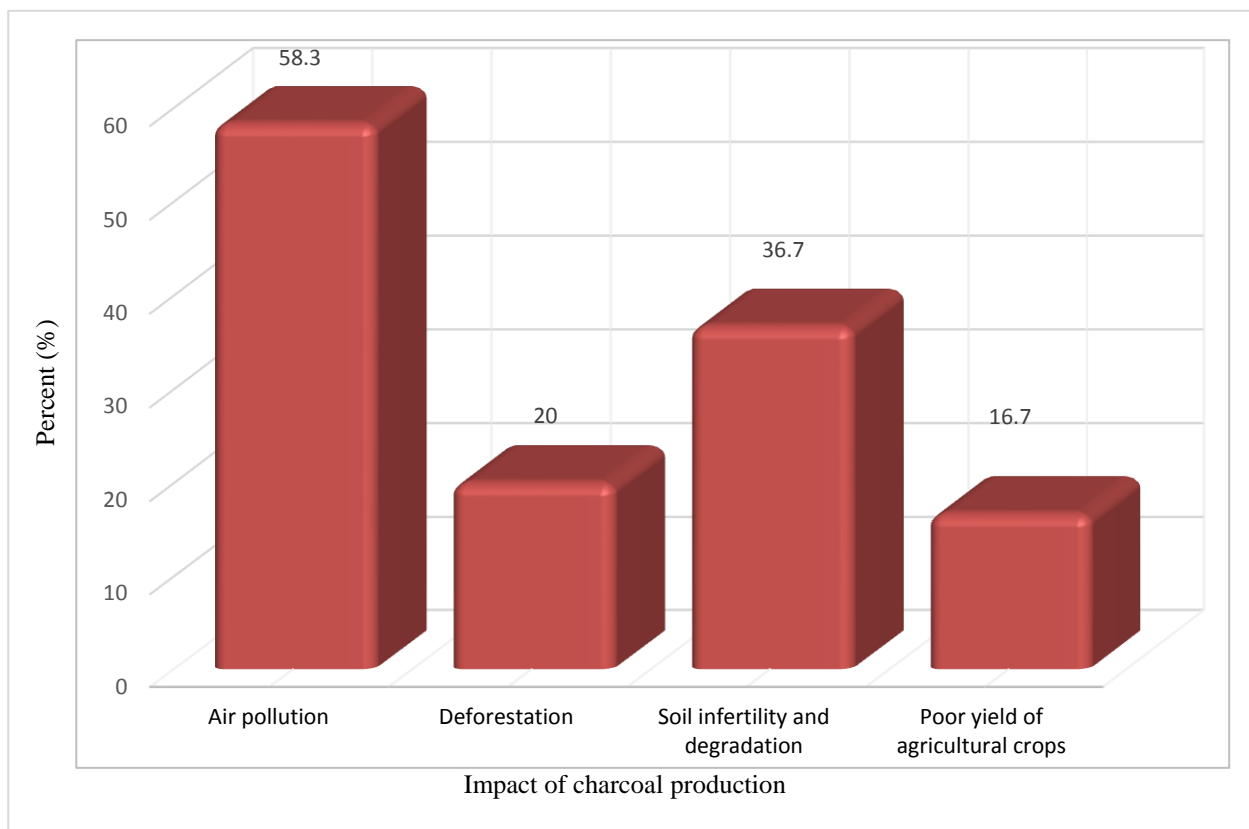


Figure-10: Perception of environmental effects of charcoal production in Adoka district.

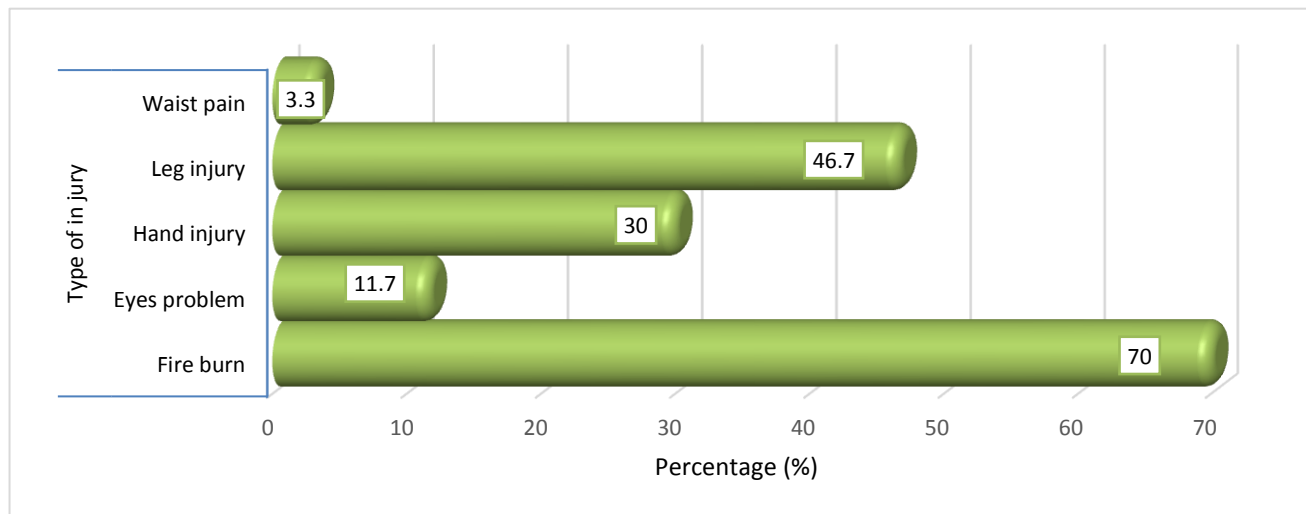


Figure-11: Types of injury caused by charcoal production to respondents in Adoka.

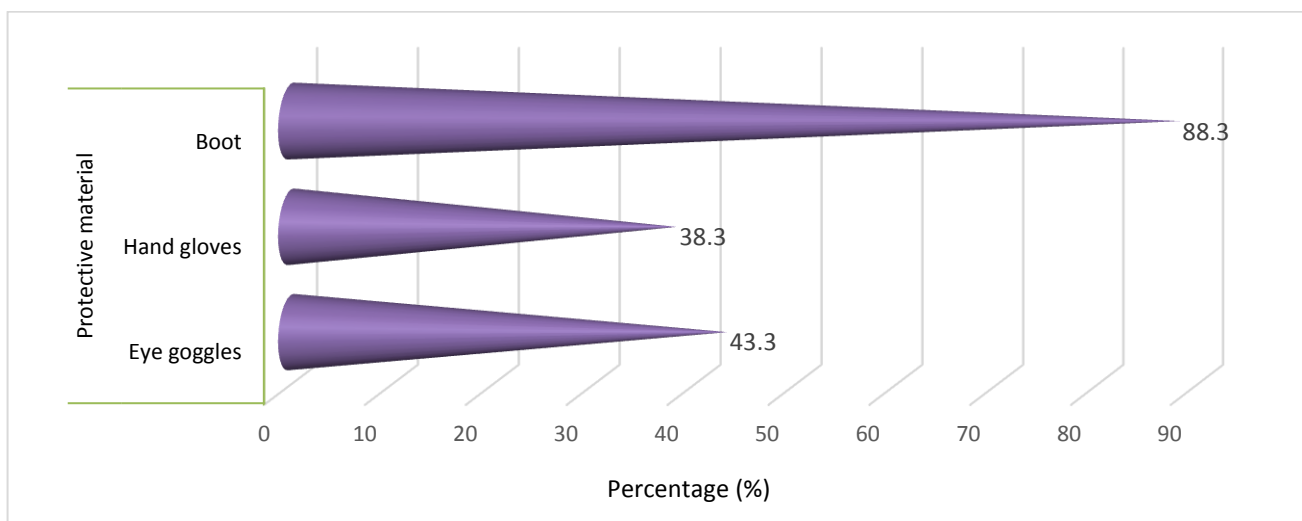


Figure-12: Protective materials used by charcoal producers in Adoka.



Figure-13: A: *Prosopis africana* cut down at Uga Adoka-Icho, B: Logs of wood ready to be buried for charcoal production in Okpeje, Adoka Ehaje.



Figure-14: Bags of Charcoal at Aune Adoka Ehaje ready for sale.



Figure-15: Earth kiln method use for charcoal production at Umogidientelkpa council.

Discussion: Married male Christian adults were more than women in charcoal making in Adoko. This may be related to the difficulty and hazardous nature of charcoal making exercise which is claimed to be peculiar to male folks as reported by several authors^{9,10,13-16}. Men are often viewed as bread winners for their households and as such, could possibly be involved in any perceived tough or dangerous jobs especially in the rural places to secure livelihoods for their family. Young adult graduates from tertiary education were mostly involved in charcoal making in Adoko. This finding might be due high rate of unemployment or under employment in Nigeria which is mostly found among youths. Unemployment rate in Nigeria was forecasted to be 32.5% and 33% respectively in 2021 and 2022 by Sasu¹⁷. This current rate of employment rate has enhanced sourcing for every available means of livelihoods by the youth in Nigeria which in this case have resulted to charcoal making. Although this has assisted them in income generation, the exercise has promoted deforestation in Adoko.

Prosopis africana was mostly chosen and exploited wood species in Adoko for charcoal making. This outcome agrees with the study of Ekhuemelo *et al.*^{9,10} and in Gwer East, Makurdi and Guma LGAs who reported that *Prosopis africana* as most preferred tree species used by charcoal makers in Guma LGA of Benue State, Nigeria. This finding is similar to the report of Adeniji *et al.*¹⁵ of charcoal making in Borgu in Niger State. However, the study is at variance with the findings of Salamatu¹⁸ who reported that *Anogeissus Leiocarpus* wood was the most utilized tree species for charcoal making in Nasarawa State.

One to five trees were felled by each charcoal producer for charcoal making in Adoko. This implies that there is high rate of deforestation in the area. Charcoal making has been reported several authors to have serious negative effects on the environment which include: global warming, desertification and climate change, poor soil and environmental degradation which

are all connected to deforestation^{15,19-22}. Traditional method of charcoal making was used in Adoka District contrary to the report of Domac, and Trosser²³ who stated that industrial charcoal making procedure was typically used in Zagreb and Croatia. Charcoal business was viewed to increase socio economic benefits to the people of Adoka which corroborates to the finding of Kamara²⁴ who reported charcoal making as means of employment to the indigenous people in the humid tropical areas of West Africa. Tunde *et al.*²⁵ pointed out that the trading business in charcoal has become a very profitable occupational in Nigeria.

Charcoal producers in Adoka district earned ₦5,000 daily from sale of charcoal. The respondents were about to meet basic family demands and livelihood. This discovery corroborates with Tunde *et al.*²⁵ that opined that charcoal making has positive impact on lives of charcoal producers since income derived was used to improved their livelihoods and hence alleviate their level of poverty. This agrees with the study of Tunde *et al.*²⁵ who stated that charcoal producers in Asa LGA of Kwara State employed the income derived from charcoal making for feeding purposes. In spite of precautional measures adopted by charcoal making, finding from this study indicated that respondents experienced some health challenges originated from charcoal making exercise and fire burn as most predominant. This discovery corroborates with the report of Salau and Keshinro²⁶ who noted that health problems that face charcoal makers in Kwara State were discomfort from smoke, body ache or fatigue, coughing, breathing challenges and uneasiness of eye. Eniola²⁰ reported backache, cough and heat as harmful effect of charcoal production exercise on human. It is very probable for producers of charcoal to inhale gases and smoke and also be exposed to accident during the tree felling, kiln preparation and management, and transportation of charcoal.

Conclusion

In this study, males were more in charcoal making business compare to their females. Many indigenous people engaged in charcoal making in Adoka whose livelihood have been improved and sustained by means of income earning, purchase of motorcycle/vehicle, erecting houses, payment of school fees and feeding and clothing. Despite these benefits, charcoal making has had adverse effects on the environment such as air pollution soil degradation and infertility in Adoka District. *Prosopis africana* was the mostly chosen and utilized wood species for charcoal making.

References

1. Bull, G. (2018). Forests and Energy. In United Nations Forum on Forests: Global Forest Goals.
2. Global Forest Watch (2022). Forest-related greenhouse gas emissions in Benue, Nigeria by dominant. driver. Accessed on 04/07/2022.
3. Kpee, F and Gana J. W. (2019). Levels and Possible Source of Polycyclic Aromatics Hydrocarbons in Soil from Charcoal Production Communities of Nassarawa State. *Scholarly Journal of Science Research and Essay*, 9(2), 24-29.
4. Zulu L. C. and Richardson R. B. (2013). Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. *Energy Sustainable Development*, 17 127 - 37.
5. Kammen D.M. and Lew D.J., (2005). Review of technologies for the production and use of charcoal. University of California, USA, 3393: 1-26.
6. William, M. and Pinto, F., (2008). Energy supply demand integrations workshop on alternative energy strategies. Mit Press, Cambridge, Pp 230 - 257.
7. Jamala G.Y., Abraham P., Joel L. and Asongo A. (2013). Socio-economic implications of charcoal production and marketing in Nigeria. *Journal of Agriculture and Veterinary Science*, 5(4), 41-45.
8. Smith, H. E., Hudson, M. D. and Schreckenber, K. (2017). Livelihood diversification: The role of charcoal production in southern Malawi. *Energy for Sustainable Development*, 36, 22–36. doi:10.1016/j.esd.2016.10.001
9. Ekhuemelo D. O., Tsembe J. I. and Amonum J. I. (2017). Investigation of Charcoal Production in Gwer West and Gwer East Local Government Areas of Benue State, Nigeria. *Asian Journal of Environment and Ecology*, 3(1), 1-13.
10. Ekhuemelo, D. O., Tembe E.T. Abah M. (2019). Evaluation of Charcoal Production in Makurdi and Guma Local Government Areas of Benue State, Nigeria. *Sustainability, Agri, Food and Environmental Research*, 7(1), 69 – 86.
11. Abah R. C. (2014). Rural perception to the effects of climate change in Otukpo, Nigeria. *Journal of Agriculture and Environment for International Development*, 108(2), 153-166.
12. Wurster, K. W. (2010). Management Matter? Effects of Charcoal Production Management on Woodland Regeneration on Senegal. Ph.D. dissertation, Department of Geography, University of Maryland, College Park. <http://drum.lib.umd.edu/bitstream/> (accessed on 30 Sept. 2022).
13. Adebayo, D.O., Adamu, C.O. and Ugege B.H. (2019). Assessment of Charcoal Production on Deforestation in selected Agrarian communities of Oyo State, Nigeria. *Journal of Research in Forestry, Wildlife and Environment*, 11(4), 125 – 131.
14. Adeniji, O.A., Zacccheaus, O.S., Ojo, B.S and Adedeji, A.S. (2015). Charcoal Production and Producers' Tree Species Preference in Borgu Local Government Area of Niger

- State, Nigeria. *Journal of Energy Technologies and Policy* 5(11).
15. Adeniji, O A., Ibrahim, A. O., Joshua, D. A., Fingesi, U. I., Osaguona P. O., Ajibade A. J., Akinbowale A. S. and Olaifa O. P. (2022). Assessment of Charcoal Production and its impact on Deforestation and Environment in Borgu Local Government Area of Niger State, Nigeria. *Journal of Applied Sciences and Environmental Management*, 26(4), 711-717.
 16. Isah A. D., Shamaki S. B., Buda S., Adamu Y. Shehu A. M., Umar L. A. and Muhammad M. (2021). Survey of Species Preference and Method of Charcoal Production in Kaduna, Nigeria Preprint (Version 1) available at Research Square. <https://doi.org/10.21203/rs.3.rs-730345/v1>
 17. Sasu, D. D. (2023). Forecast unemployment rate in Nigeria in 2021 and 2022.
 18. Salamatu E. A., Ayuba H. K., Marcus D. N., and Ogah A. T. (2021). Analysis of Tree Species Preference and Reasons among Commercial Charcoal Producers in Nasarawa State, Nigeria. *European Journal of Environment and Earth Sciences*, 2(2), 24 – 29.
 19. Eniola P. O. (2014). Perceived environmental and health effects of charcoal production among rural dwellers in agro-ecological zones of Nigeria. U.I Ph.D thesis.
 20. Eniola, P. O. (2021). Menace and Mitigation of Health and Environmental Hazards of Charcoal Production in Nigeria. W. Leal Filho et al. (eds.), African Handbook of Climate Change Adaptation, Springer Nature Switzerland.
 21. Ogundele A.T., Eludoyin O. S. and Oladapo O. S. (2011). Assessment of impacts of charcoal production on soil properties in the derived savanna, Oyo state, Nigeria. *Soil Science and Environmental Management*, 2(5),142-146.
 22. Oguntunde P. G., Abiodun B. J., Ajayi A. E. and Giesen N. (2008). Effects of charcoal production on soil physical properties in Ghana. *Journal of Plant Nutrition and Soil Science*, 171, 591-596.
 23. Domac J. and Trossero M. (2008). Industrial Charcoal Production. Zagreb: North-west, Croatia Regional Energy Agency. Pp 34.
 24. Kamara J. N. (1986). Firewood energy in Sierra Leone, production, marketing and household use pattern studies. No. 9 Verlag Wetarchiv, Hamburg, West Germany, 5(4):41-45.
 25. Tunde A. M. Adeleke E. A. and Adeniyi E. E. (2013). Impact of charcoal production on the sustainable development of Asa local government area, Kwara State, Nigeria. *International Multidisciplinary Journal, Ethiopia*, 7(2), 1-15.
 26. Salau, S. A. and Keshinro, O. O. (2015). Economics of Charcoal Production among Producers in Kwara State, Nigeria. *International Journal of Agricultural Economics and Rural Development*, 7(1), 38-43.