

Investigation of Charcoal Production in Gwer West and Gwer East Local Government Areas of Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author DOE designed and interpreted the manuscript. Author JIA analyzed and prepared the manuscript. Author JIT managed the literature search. All authors read and approved the final manuscript.

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ABSTRACT

This study assessed charcoal production in Gwer west and Gwer east Local Government Areas (LGAs) of Benue State, Nigeria. It was aimed at to identifying charcoal producing villages, preferred wood species used, market channels, awareness of the implication of environmental and socio-economic benefits of charcoal production. Snowball sampling technique was used to identify charcoal producing villages. Mult-stage sampling technique was employed to select respondents for data collection. Five villages were randomly selected and visited in each LGAs, in each village, five charcoal producers were chosen. 150 copies of semi-structured questionnaire were used in the two LGAs. Data collected were analyzed with descriptive statistics and one way ANOVA. Results show that there were more male than female in charcoal production business. In Gwer east, preferred wood species for charcoal production were in the order of *Prosopis africana* (33%) > *Khaya senegalensis* (27%) > *Terminelia avicenniodes* (20%) > *vitellaria paradoxa* (13%) > *Burkia africana* (7%). In Gwer west, the order of wood preference was *Prosopis africana* (29%) > *Anogeissus leiocarpus* (24%) > *Burkia africana* (19%) > *Azelia africana* (14%) > *Vitellaria paradoxa*

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(9%) > *Erythrophleum suaveolens* (5%). In Gwer west LGA, Aondoana village had highest mean of 24.30 ± 13.83 charcoal production while in Gwer East LGA, Taraku had highest mean (11.10 ± 7.84). Number of charcoal producers in the two LGAs were not significant ($p < 0.05$). In Gwer west, charcoal producers in Aondoana village had highest (32%) earnings of between N 201,000 - N 250,000 monthly and highest employees (32.42%). Whereas, in Gwer west LGA, Taraku charcoal producers highest earning was between ₦ 161,000 - ₦ 200,000 monthly and also had highest employee of 31%. There is no significant difference ($p < 0.05$) in the presence of market in the LGAs. The highest percentage earnings in Gwer west and In Gwer east was used for marring (39%, 37%) beside others. Perceived environmental problems by respondents were climate change (30%) > soil erosion (25%) > loss of watershed (20%) > loss of habitat (15%) > extinction of plant species (10%) > land dispute (5%). It was concluded that as charcoal production has both positive and negative impact on the producers, inhabitants and the environment, efforts should be made mitigate the negative effects.

Keywords: Charcoal; earning; Gwer west; Gwer east; wood species.

1. INTRODUCTION

Forests have been an important source of energy throughout human history. Traditional forms of forest biofuel include firewood and charcoal for heating and cooking, which it is still used in many parts of the world [1]. Tree and its wood have played a prominent role in human life throughout history. Wood is the most versatile raw material the world has ever known. Throughout history people relied on wood for varying needs such as fuel wood, charcoal production, building materials etc. Wood is a porous and fibrous structural tissue found in the stems roots of trees and other woody plants.

Charcoal production and demand as reported by [2] are on the increase in developing countries and international market respectively. Charcoal is one of the major components or fractions of wood fuel. Wood charcoal is processed from wood and wood materials from trunk, branches and other parts of trees and shrubs, processed by burning and passing through fire [3]. 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. 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 [2].

Charcoal been an old source of energy is as well still a modern source of energy for cooking in both rural and urban centers. [4] 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%. [5] reported that 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 be able to afford both the energy resources and the devices required to use these forms of energy. Many households, therefore, turn to using kerosene or charcoal. In Nigeria, studies in Benue state show the main uses of charcoal to be for cooking. In Benue state Nigeria, wood fuels have been a traditional source of energy for cooking. However the production of charcoal has recently arrived and is beginning to be observed more frequently.

Charcoal in general term is a range of carbonized materials, with varying combustion and dark properties [6]. It is usually produced by raising the temperature of wood beyond the point at which many of its organic components become chemically unstable and begin to break down. The details of this process, called pyrolysis, are still incompletely understood. Most of the newly formed materials are vaporized. The material left behind is a black, porous charcoal that retains the original form of the wood but has just one fifth the weight, one half the volumes, and about one third of the original energy content [6]. To prevent most of the wood from igniting during production (pyrolysis), charcoal must be made in an environment of restricted air flow.

The exploitation of forest resources for fuel wood and charcoal remains a hard-hitting challenge to most pastoral communities in Nigeria [7]. Human activities, such as charcoal production, are increasing the pace of deforestation. Charcoal production at sub-industrial levels is one of the primary causes of deforestation. Land degradation is another well known problem resulting from deforestation activities for whatever purpose including charcoal production. According to [8], Nigeria has lost more than 75 percent of her 8.2 million hectares of forest cover over the past few decades. The rate of charcoal production in Gwer west and Gwer east Local Government Areas (LGAs) of Benue State in the recent years has increased in diversity and magnitude. This is further compounded by massive trading in and across the LGAs as a means of livelihood. Due to increase in population and poverty, the forest resource of Gwer west and Gwer east LGAs have drastically reduced as rural dwellers indulge in illegal activities such as charcoal production, logging and gathering of fuel wood. Therefore protective measures have to be taken to ensure that the resource do not go into extinction. There is no documented information on charcoal production in Gwer west and Gwer east LGAs despite the high rate of charcoal production and market in the area. Therefore, the objectives of this work were to:

- i. Identify villages involved in charcoal production in Gwer west and Gwer east LGAs.
- ii. Identify wood species used and market channels for charcoal production in the study area.
- iii. Assess level of awareness of environmental impact and the socio-economic benefits of charcoal production to the area.

2. MATERIALS AND METHODS

2.1 Study Areas

This study was conducted in Gwer West and Gwer East LGAs of Benue State. Gwer West LGA is located between latitudes 9 and 12°N and longitudes 6 and 9°E. It is bounded by Makurdi and Guma LGAs to the north, Gwer East LGA to east, Otukpo LGA to the South and Apa and Agatu LGAs to the West. The headquarters of the LGA is Naka which is strategically located at kilometre 40 along the Makurdi - Ankpa interstate road. Gwer West LGA has annual

rainfall of between 1500 mm and 2000 mm. The LGA occupies a landmass of about 456.45 sq km. According to the 2006 census (projected figures for 2015), Gwer West LGA has a population of 154,942 [9,10]. Gwer East LGA is situated approximately between Latitude 7°- 8°N and Longitude 7°-8°E of the Greenwich Meridian. The LGA is bounded by Makurdi LGA to the North, Gwer West and Otukpo LGAs to the West, Gboko and Tarka LGAs to the East and Obi and Konshisha LGAs to the South. Gwer East LGA has an area of 2294 km² and a population of 168,660 people [11]. Agricultural activities practiced in the area include farming, fishing and hunting.

2.2 Vegetation of the Study Area

The vegetation of the study area is guinea savanna characterized by dense grass cover consisting of dominant species of trees like, *Burkea africana*, *Daniellia oliveri*, *Khaya senegalensis*, *Prosopis africana*, *Azadirachta indica*, *Parkia biglobosa*, *Vitellaria paradoxa*, *Citrus* spp, *Tamarindus indica* among others. Benue state Government, in 2010, gazetted twenty two (22) tree species as economic trees under protection. The tree species include *Prosopis africana*, *Parkia biglobosa* and *Khaya senegalensis* etc. [12] observed three types of forest in the Nagi District of Gwer west LGA. According to him, they include: Wild forest, Gallery forest and Reserved forest. He reported that the wild forest covered a greater area of the Nagi region. He claimed that, that type of forest grows naturally and little attention was given to it by forest managers. The gallery forest type according to [12] occurs along river banks. Moisture from the river valley supports the growth of such trees on the bank. This type of forest was not wide spread because its limitation to riverbanks. The reserved type of forest was part of the wild forest that was protected by forest managers. The land was declared reserved in 1965 by the Tiv Native Authority and named "Mbakpa Forest Reserve" [13].

2.3 Experimental Design

The villages where charcoal producing villages were identified using snowball sampling techniques (by inquiring from selected target group). The target group includes charcoal marketers, farmers, villagers, and village head in the study areas. Thereafter the identified charcoal producing villages were randomly selected and visited.



Fig. 1. Map of Gwer west and Gwer east LGAs

The study area

Table 1. Administration of questionnaire in the study area

S/no.	LGA	No of villages	Target of respondents in each village	No. of questionnaire	Total no of questionnaire
1	Gwer West	5	i. charcoal producers	5	50
			ii. charcoal marketers	5	
2	Gwer East	5	i. charcoal producers	5	50
			ii. charcoal marketers	5	
Total					100

A Multi-stage sampling technique was employed to select respondents for data collection. Personal interview and semi-structured questionnaire were used. Five (5) villages were selected and in each villages in the LGAs. Five (5) charcoal producers/production sites were selected in each village among the identified ones. Ten copies (10) of questionnaire were administered in each village as shown in Table 1 above.

2.4 Data Collection Techniques

A total number of one hundred (100) copies of semi-structured questionnaire were used in the two LGAs. That is, fifty in each LGA. Ten copies of the semi-structured questionnaire was administered in each charcoal producing villages which five each is administered to charcoal producers and charcoal marketers respectively.

2.5 Data Analysis

Data collected from this study is analyzed with descriptive statistics and one way Analysis of variance (ANOVA).

3. RESULTS

3.1 Demographic Information of the Respondent in Gwer West and Gwer East LGAs

Fig. 2 shows the demographic information of the respondents in Gwer west and Gwer east LGAs. The results revealed that in both Gwer west and Gwer east, male (78% and 73%) were higher in charcoal production than female (22% and 27%). Similarly, both Gwer west and Gwer east had charcoal producers (42% and 35%) mostly in the

age class of 21-30 years and majority of them were married (39.62% and 52%). Most of the respondents had informal education of 44.77% and 47.62%, while their predominant occupation was farming (61% and 59%) in Gwer west and Gwer east LGAs respectively.

3.2 Names of Wood Species Mostly Use in Gwer West and Gwer East

Table 2 shows the number of charcoal producers in each village in the study area. The result shows that Gwer west had a higher number (484) of charcoal producers that Gwer east (345). However Aondoana and Agagbe villages in Gwer west had 43.18% and 23.75% charcoal producers while in Gwer east, Taraku and Mbabul villages had 24.63% and 23.17% charcoal producers respectively. There were significant differences among the means of charcoal producers in the villages of the two LGAs.

3.3 Preferred wood Species for Charcoal Production in the Study Area

Table 3 shows wood species used for charcoal production in the study areas. *Azelia africana*,

Burkea africana, *Terminelia avicenniodes* *Prosopis africana* *Vitellaria paradoxa* were general wood species used for charcoal production in both Gwer west and east LGAs. However, *Mangifera indica*, *Parkia biglobosa*, *Tectona grandis* and *Khaya senegalensis* were common to Gwer west, whereas in Gwer east, *Anogeissus leiocarpus*, *Erythrophleum suaveolens*, *Mitrogyna inermis* and *Gmelina arborea* were found to be used.

3.4 Ranking of Preferred Tree Species for Charcoal Production in Gwer West and Gwer East

Table 4 records ranking of preferred wood species used for charcoal production in Gwer west and Gwer east LGAs. *Prosopis africana* was the most preferred wood species used in charcoal production in both Gwer west (33%) and Gwer east (29%) LGAs. *Khaya senegalensis* (27%) and *Anogeissus leiocarpus* (24%) wood species ranked second in Gwer west and Gwer east respectively. The least preferred wood species in Gwer west and Gwer east were *Burkia africana* (7%) and *Erythrophleum suaveolens* (5%).

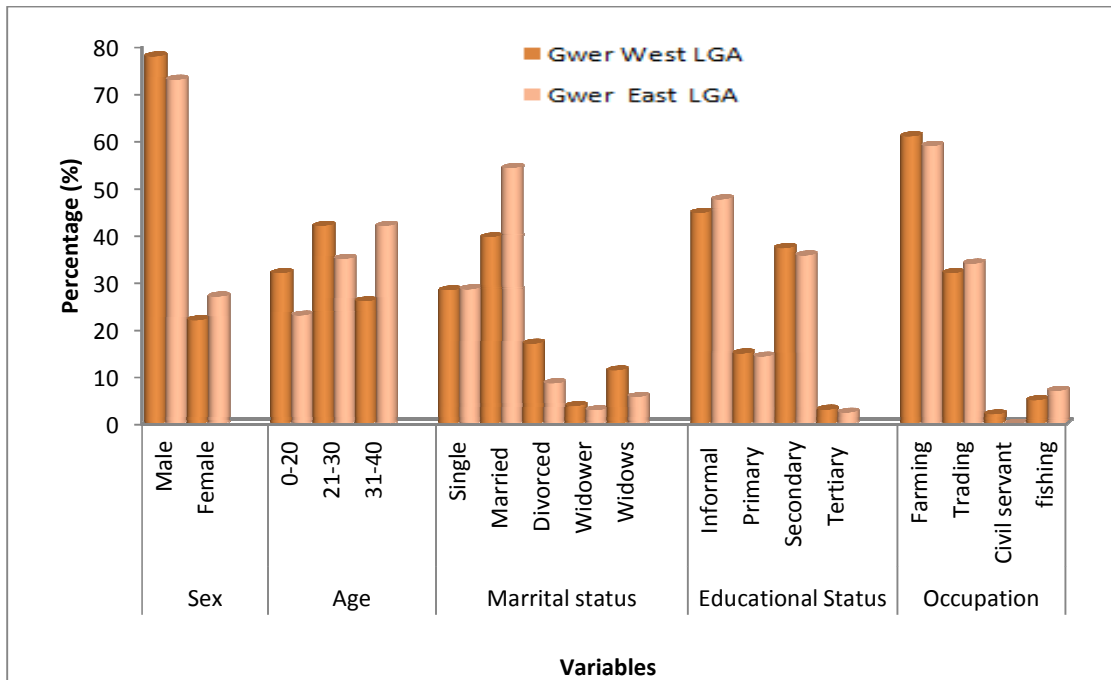


Fig. 2. Demographic information of the respondents in Gwer west and Gwer east LGAs of Benue State

Table 2. Number of charcoal producers in each village in Gwer west and Gwer east LGAs

S/no.	LGA	Villages	No. of producers in each village		N	Mean number of charcoal producers Mean ± SD
			F	%		
Gwer west						
1		Aondoana	209	43.18	10	24.30 ^h ±13.83
2		Agagbe	115	23.76	10	16.50 ^g ±12.07
3		Achagh	80	16.53	10	9.50 ^{de} ±8.55
4		Abena	50	10.33	10	7.00 ^b ±5.14
5		Gor	30	6.19	10	8.80 ^{bc} ±6.22
			484	100		
Gwer east						
6		Taraku	85	24.63	10	11.10 ^f ±7.84
7		Mballim	70	20.28	10	9.20 ^{cd} ±5.27
8		Mbabul	80	23.19	10	7.10 ^b ±5.63
9		Mbakume	60	17.39	10	6.10 ^a ±5.24
10		Jendee	50	14.49	10	5.50 ^a ±5.10
		df	345	100		9
		F stat				5.14
		P. value				0.000

Table 3. Wood species used for charcoal production in Gwer west and Gwer east LGAs

S/no.	LGA	Family	Scientific names	Common Names	Tiv Names
1	Gwer east	Anacardiaceae	<i>Mangifera indica</i>	Mango	Mango
		Caesal pinioideae	<i>Azelia africana</i>	Cotton wood	Yiase
			<i>Burkea africana</i>	Wild syrnge	Gbagbongom
		Combretaceae	<i>Terminelia avicenniodes</i>	-	Kuegh
		Fabaceae	<i>Parkia biglobosa</i>	Locust bean	Nune
		Lamiaceae	<i>Tectona grandis</i>	Teak	Kpar
		Miliaceae	<i>Khaya senegalensis</i>	Mahogany	Haa
		Mimosoideae	<i>Prosopis africana</i>	Iron wood	Gbaaye
		Sapotaceae	<i>Vitellaria paradoxa</i>	Shea butter tree	Ichamegh
		Verbenaceae	<i>Vitex doniana</i>	Black plum	Hulu
2	Gwer west	Caesalpinioideae	<i>Afelia africana</i>	Cotton wood	Yiase
			<i>Burkea africana</i>	Wild syrnge	Gbagbongom
		Combretaceae	<i>Terminelia avicenniodes</i>	-	Kuegh
			<i>Anogeissus leiocarpus</i>	Chewing stick tree	Maaki
		Erythroxylaceae	<i>Erythrophleum suaveolens</i>	Sass wood	Kor
		Mimosoideae	<i>Prosopis africana</i>	Iron wood	Gbaaye
		Rubiaceae	<i>Mitrogyna inermis</i>	Abura tree	Shonor
		Sapotaceae	<i>Vitellaria paradoxa</i>	Shea butter tree	Ichamegh
		Verbenaceae	<i>Gmelina arborea</i>	Gmelina	Melina

3.5 Number of Logs Felled Per Production/Duration of Charcoal Production Process

Table 5 shows number of logs felled and duration of charcoal production process. In Gwer west, number of logs felled per production in Aondoana, Agagbe and Achagh were between (36.66%, 26.67% and 20%) while in Gwer east, they were 34%, 21% and 19% in Taraku,

Mbakume and Mbabul respectively. In Gwer west, the percentage of logs felled per week in Gor, Abena and Aondoana were 35%, 23% and 18%, while in Gwer east Taraku, Mballim, and Mbakume felled 38%, 25% and 19% respectively. The result further show that duration of production process ranged from 7-14 days and raining season was most preferable period for charcoal production in the study area.

Table 4. Ranking of preferred tree species for charcoal production in Gwer west and Gwer east LGAs

S/no.	LGA	Scientific names	Ranking		Other uses of preferred tree species
			F	%	
1	Gwer east	<i>Prosopis africana</i>	1	33	Local bridge construction, Fire wood, medicinal purposes and fruit for soup making. Ruffling of houses, fire wood, medicinal purpose and local bridge construction. Oil for wound treatment, ruffling of houses, and fire wood. Fire wood and medicinal purposes. Ruffling of houses, local bridge construction, medicinal purpose and Fire wood
		<i>Khaya senegalensis</i>	2	27	
		<i>Vitellaria paradoxa</i>	3	13	
		<i>Terminelia avicenniodes</i>	4	20	
		<i>Burkia africana</i>	5	7	
		Total	15	100	
2	Gwer west	<i>Prosopis africana</i>	1	29	Local bridge construction, medicinal purpose and fruit for soup making Ruffling of houses and Fire wood Ruffling of houses Soap making, local medicine and local bridge construction Fruit used for soup making and medicinal purposes. Canoe making, medicinal purpose and local bridge construction
		<i>Anogeissus leiocarpus</i>	2	24	
		<i>Burkia africana</i>	3	19	
		<i>Azelia africana</i>	4	14	
		<i>Vitellaria paradoxa</i>	5	9	
		<i>Erythrophleum suaveolens</i>	6	5	
		Total	21	100	

Table 5. Number of log felled and duration of charcoal production process in the study area

S/no.	LGA	Villages	No of log felled per production		No of log felled per day		Duration of production process	Season for the production
			F	%	F	%		
			1	Gwer west	Aondoana	17		
		Agagbe	8	26.67	2	11.76	-	-
		Achagh	6	20.00	2	11.76	-	-
		Gor	3	10.89	6	35.29	-	-
		Abena	2	6.67	4	23.53	-	-
		Total	30	100	17	100		
2	Gwer east	Taraku	11	34.38	6	37.5	7-14days	Raining season
		Mbakume	7	21.88	3	18.75	-	-
		Mbabul	6	18.75	1	6.25	-	-
		Mballim	5	15.63	4	25	-	-
		Jandee	3	9.38	2	12.5	-	-
		Total	32	100	16	100		

3.6 Respondents Efforts in Tree Plant

Table 6 shows respondents efforts in tree planting exercise. In Gwer west, there was high percentage of forest plantation in Achagh, Agagbe and Aondoana, with 30%, 30% and 25% mainly with through forest plantation. Whereas in Gwer east LGA, there was high percentage of forest plantation in Taraku, Jandee and Mballim (28%, 22% and 19%) respectively. The result

indicates high level of forest plantation practices by respondents in study area.

3.7 Socio-economics of Charcoal Production in the Study Area

Table 7 shows socio economics of charcoal production in Gwer west and Gwer east LGAs. In Gwer west, charcoal producers in Aondoana village earned highest (32%) of between

₦ 201,000 - ₦ 250,000 monthly during production season and also had highest number of employees (32.42%). Whereas, Abena village earned the least (9%) income of between ₦ 0 - ₦ 50,000 and least employees (8.11%). Agagbe charcoal producers earned between ₦ 151,000 - ₦ 200,000 (23%) as Achagh earned between ₦ 101,000 - ₦ 150,000 (20%) monthly. However, Gor charcoal producers earned between ₦ 51,000 - ₦ 100,000 (16%). The number of employee also varies accordingly with the earnings in the villages.

In Gwer west LGA, Taraku charcoal producers earned highest monthly income of between ₦ 161,000 - ₦ 200,000 and highest employee of 31%. On the contrary, Jandee village earned the least income of between ₦ 0 - ₦ 40,000 (8%) as well as had least employees (8%). Mballim charcoal producers earned between ₦ 121,000 - ₦ 160,000 (25%) whereas Mbabul charcoal producers earned between ₦ 81,000 - ₦ 120,000

(20%) monthly. Similarly, Mbakume charcoal producers earned between ₦ 41,000 - ₦ 80,000 (16%) monthly. The higher the earnings employees the higher the number of employers.

3.8 Market Channels of Charcoal Sales in Gwer West and Gwer East

Table 8 shows the results of market channels of charcoal sales in Gwer west and Gwer east. Results from Gwer west show that, 54% of respondents reported that there was presence of market for their products. The types of market were wholesale (48%) and retail (55%). However, 54% of charcoal products were sold within Benue State while 44% were sold to other States. In Gwer east LGA, 58% of respondents asserted that there was no market for their products. The types of market were wholesale (52%) and retail (45%). Nevertheless, 56% of charcoal products were sold within Benue State whereas 46% were sold to other States.

Table 6. Respondents efforts in tree plant in Gwer west and Gwer east LGAs

S/no.	LGA	Villages	Replanting methods						
			Forest plantation		Agroforestry		Home gardens		
			F	%	F	%	F	%	
1	Gwer west	4	Abena	0	0	5	25	0	0.0
		1	Achagh	8	30	1	5.0	0	0.0
		5	Agagbe	8	30	6	30	2	67
		2	Aondoana	7	26	3	15	0	0.0
		3	Gor	4	14	5	25	1	33
			Total	27	100	20	100	3	100
2	Gwer east	2	Jande	7	21	5	31	1	12
		4	Mbabul	6	19	3	19	1	12
		3	Mbakume	4	13	3	19	3	38
		1	Mballim	6	19	4	25	3	38
		5	Taraku	9	28	1	6	0	0.0
			Total	32	100	16	100	8	100

Table 7. Socio economics of charcoal production in Gwer west and Gwer east LGAs

S/no.	LGA	Villages	Monthly earning			No. of employees	
			(₦ k)	F	%	F	%
1	Gwer west	Abena	0-50,000	12	9	3	8.11
		Gor	51,000-100,000	20	16	5	13.51
		Achagh	101,000-150,000	25	20	7	18.92
		Agagbe	151,000-200,000	30	23	10	27.03
		Aondoana	201,000-250,000	41	32	12	32.43
			Total		128	100	37
2	Gwer east	Jandee	0-40,000	9	8	2	8.00
		Mbakume	41,000-80,000	18	16	4	16.00
		Mbabul	81,000-120,000	23	20	3	12.00
		Mballim	121,000-160,000	29	25	7	28.00
		Taraku	161,000-200,000	35	31	9	36.00
					114	100	25

3.9 Benefits from Charcoal Production in the Study Area

Table 9 shows the benefits of charcoal production in Gwer west and Gwer east LGA of Benue state. In Gwer east, the highest percentage earnings was used for marring followed by building of houses, feeding and clothing with (39%, 21% and 20%). While in Gwer west, marring, paying of school and building of houses (37%, 24% and 24%) were observed as livelihoods of the villages from charcoal production. The result indicate that the producer used high percent of their earning for marring.

3.10 Perceived Environmental Problems from Charcoal Production in Study Area

Fig. 3 indicates the implications of falling trees for charcoal production in the study area. From the result, most producers (30%) believed that their activities were responsible for climate change, whereas 25% claimed soil erosion as a problem. Furthermore, 20%, 15%, 10% and 5% of the charcoal producers attributed their activities to loss of watershed, loss of habitat, extinction of plant species and land dispute respectively.

Table 8. Market channels of charcoal sales in Gwer west and Gwer east LGAs

S/No	LGA	Presence of market				Types of market				Market channels			
		Yes		No		Wholesale		Retailer		Benue State		Other State	
		F	%	F	%	F	%	F	%	F	%	F	%
1	Gwer west	38	54	11	42	32	48	17	55	20	54	29	44
2	Gwer east	33	46	15	58	34	52	14	45	23	56	25	46
	Total	71	100	26	100	66	100	31	100	43	100	54	100

Table 9. Benefits from charcoal production in Gwer west and Gwer east LGAs

S/no.	Livelihood from charcoal producers	Gwer east		Gwer west	
		F	%	F	%
1	Feeding and clothing	18	20.22	15	15.30
2	Marring	35	39.32	36	36.73
3	Building of houses	19	21.34	23	24.46
4	Paying of school	17	19.10	24	24.48
	Total	89	100	98	100

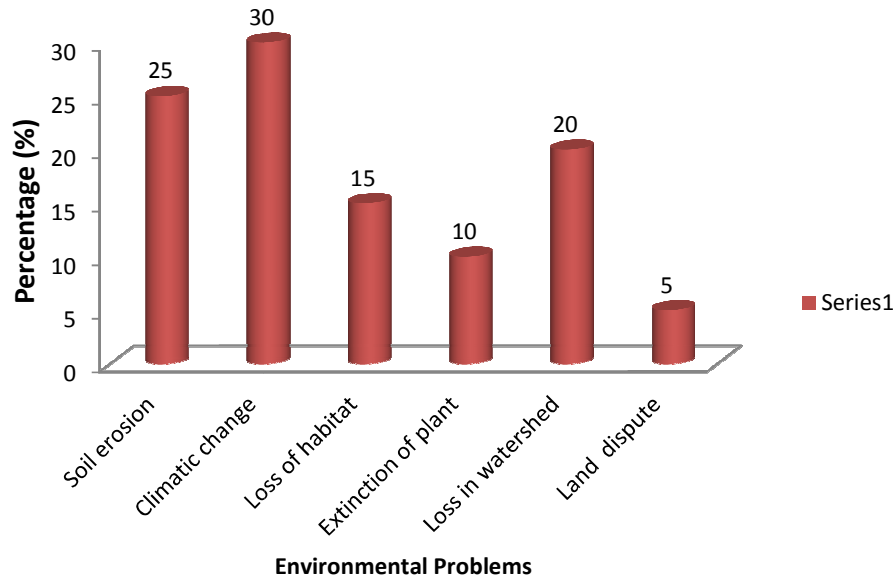


Fig. 3. Implication of falling trees for charcoal production in the study area

Plate 1 shows bags of charcoal in Achegh in Gwer west LGA ready for sale, while Plate 2 revealed piled of wood prepared for production in Mbabul, Gwer East LGA. Plate 3 is *Gmelina arborea* plantation in Agagbe, Gwer west LGA. Plate 4 displayed bags of charcoal in Taraku in Gwer East LGA ready for Transport to another state.



Plate 1. Bags of charcoal in Achegh in Gwer west LGA ready for sale



Plate 2. Piled of wood prepared for production in Mbabul, Gwer East LGA



Plate 3. *Gmelina arborea* plantation in Agagbe, Gwer west LGA

4. DISCUSSION

Many villages were found to be involved in charcoal production in the study areas. The result indicates that there was higher rate of

charcoal producers in Gwer west than Gwer east. This may be as a result of higher vegetation cover with many tree species in the area compared to Gwer west. Aondoana accounted for the highest rate of charcoal production with 209 estimated number of producers in Gwer west, while in Gwer east, Taraku was the highest with 85 estimated number of producers. This high number of charcoal producers in the study area may lead to destruction forest in the area as reported by [3] who asserted that production of Charcoal was one of the activities leading to destruction of forest cover in Nigeria, a situation which was motivated by illegal commercial logging.



Plate 4. Bags of charcoal in Taraku in Gwer East LGA ready for Transport to another state

The most preferred wood species for charcoal product in Gwer west and Gwer east LGAs was *Prosopis africana*. This finding confirms the study of [5] who reported that *Prosopis africana* was the most preferred tree species used by charcoal producers in Borgu Local Government Area of Niger State, Nigeria. This is further agrees with [2,14] who stated that *Prosopis africana* was used all over the tropics, and as a good hardwood, it has become a choice all over the world where charcoal is produced. [15] in a study at Nagi Forest Reserve, Gwer- West LGA of Benue state claimed that tree species with the highest frequency of occurrence was *Prosopis africana* and most dominant. Their result further shown that *Prosopis africana* also recorded the highest mean basal area. Other common species in the study area include *Prosopis africana*, *Parkia biglobosa* and *Khaya senegalensis*, with *Prosopis africana* recording the highest number of trees. This was perhaps the reason why *Prosopis africana* was the most preferred species used for charcoal production in the study area. [16] observed that charcoal producers and their preference for particular tree species are some of the key known factors destroying the vegetation.

Traditional method of charcoal production was used in both Gwer west and Gwer east the LGAs

contrary to the report of [17] which states that industrial charcoal production method was commonly used in Zagreb, Croatia. Charcoal was observed to increase socio-economic benefits to the people of Gwer West and Gwer East LGAs similar to the findings of [18] that charcoal production provides a source of employment to the rural dwellers in the humid tropical areas of West Africa. [19] pointed out that the business of trading in charcoal has now become a very lucrative venture in Nigeria.

This study reveals that charcoal producers in Gwer west and Gwer east earned so much from their business and were able to meet family needs. This finding agrees with [19] who reported that charcoal production has important aspect of the positive impact on the lives of the producers since income realized was always used to improve their wellbeing and hence reduce their poverty situation. This further observed that charcoal producers in study area used their earnings majorly for marrying wife. This disagrees with the study of [19] who reported that charcoal producers in Asa LGA, Kwara State claimed they used the income they realized from charcoal production for purchase food items.

In this study, respondents were aware that charcoal production has adverse environmental impact with climate change accounting for the highest. This is similar to a study carried out by [20] that emissions of greenhouse gases from charcoal production in tropical ecosystems in 2009 are estimated at 71.2 million t for carbon dioxide and 1.3 million t for methane. This is also in agreement with [16] 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 [3]. [20] reported that charcoal production in tropical regions of the world was often perceived to have devastating ecological and environmental effects. The most commonly cited impact is deforestation (clearance of forest or woodland). [21,22] claimed that in almost all countries where charcoal is produced, there have been reports highlighting concern about deforestation and forest degradation that accompanies the production process. Similarly, [23] reported that charcoal-based energy demand has been identified as a mechanism of forest cover change in Africa. [24] in their study on impact of charcoal production on forest degradation: a case study in Tete, Mozambique, found out that charcoal production was a main contributor of forest

degradation. They reported that in charcoal producing districts, charcoal production was largely independent from agricultural expansion. They further asserted that area of forest degradation associated to charcoal production was larger than the area of deforestation and over larger geographical areas it was as high as 50% of the deforested 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 practice. The efforts by the respondents may be because they were aware of the future danger post to their business if tree cut were not replaced.

5. CONCLUSION

Many villages were involved in charcoal production in the study area. *Prosopis africana* was the most preferred and utilized wood species for charcoal production. Charcoal was observed to increase socio-economic benefits to the people of Gwer west and Gwer east LGAs mostly for marrying wife. However, charcoal production was believed to adversely affect the environment in the study area. It was observed that respondent in this study areas use their earning income for marrying of wives and building of houses. 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.

6. RECOMMENDATIONS

1. The local government forest extension workers should sensitize the surrounding communities on the roles and benefits of woody plants to environmental and humanity at large.
2. The Government should encouraged these rural dwellers on the use of alternative fuels by bringing down the cost and making them readily available , fuels like gas and kerosene will reduce the pressure on the concentration and dependence on forest wood resource for fuel.

3. The Local Governments should ensure intense campaign on the consequences of forest depletion due to indiscriminate use of forest resources for fuel energy. Gwer West and Gwer East Local Government should set up a body or committee that will be monitoring the activities of the natural forest on daily basis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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