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ASSESSMENT OF TREE SPECIES UTILIZED AND ANNUAL OUTPUT OF CHARCOAL PRODUCTION IN SOUTHWESTERN NIGERIA

*[1]Olabimisi, A.D.; [1]Ajuwon, I.O.; [1]Alabi, A.F. & [1]Oladoyinbo, O.B.

[1]Agricultural Technology Department, Oyo State College of Agriculture and Technology, P.M.B. 10, Igboora, Oyo State, Nigeria.

*Corresponding Author

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ABSTRACT

This study assessed the tree species utilized and the annual output of charcoal production in Southwestern Nigeria. Specifically, it examined the socio-economic characteristics of charcoal producers, identified the tree species used and quantity of charcoal produced annually, investigated factors influencing charcoal production, and assessed constraints hindering hazard management practices. A multistage sampling technique was used to select 381 charcoal producers from three purposively selected states: Oyo, Osun, and Ogun. Data were collected through structured questionnaires and analyzed using descriptive statistics, weighted mean scores, and Analysis of Variance (ANOVA).

The results showed that the majority (64.57%) of producers were aged 36–45 years with a mean age of 42 years, while 80.83% were male and 67.19% were married. The mean household size was 9 members and the average annual income from charcoal production was ₦425,866.10. Commonly used hardwood species included *Terminalia glaucancens*, *Dialium guineense*, *Butyrospermum paradoxum*, and *Tectona grandis*, while softwood species such as *Mangifera indica* and *Parkia biglobosa* were used when hardwood was scarce. Annual charcoal output ranged from 66,940.54 kg to 167,115.73 kg. Major constraints to hazard management included inadequate healthcare facilities, unstable government policies, poor monitoring, and high cost of protective equipment. ANOVA results showed no significant difference in charcoal output across the states ($F = 0.78$; $p > 0.05$). The study recommends sustainable forest management and improved charcoal production technologies.

Keywords: Charcoal production, tree species utilization, biomass energy, forest resources, rural livelihoods, Southwestern Nigeria.

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INTRODUCTION

In Nigeria, biomass fuels such as firewood and charcoal continue to dominate the domestic energy sector because of their affordability and accessibility, especially among low-income households. Charcoal is widely used for cooking in both rural and urban areas because it burns longer, produces less smoke than firewood, and is easier to transport and store. As a result, charcoal production has become a significant economic activity that provides employment and income for many rural households. This increasing demand has stimulated commercial charcoal production across different regions of Nigeria, particularly in forest-rich areas. In Southwestern Nigeria, charcoal production has become a major livelihood activity among rural dwellers who depend largely on forest resources for their income and survival. The region, which includes Oyo, Ogun, Ondo, Osun, Ekiti, and Lagos States, possesses significant forest resources that are often exploited for charcoal production. Charcoal is produced through the carbonization of wood in a limited oxygen environment using traditional methods such as earth mound or pit kilns. These methods involve the slow burning of wood to convert it into charcoal, which is then packaged and transported for sale in local and international markets. Studies have shown that charcoal production plays an important role in rural livelihoods, providing employment opportunities and contributing to income generation. However, the increasing reliance on wood resources for charcoal production has raised serious concerns about environmental sustainability and forest resource depletion (Adeniji et al., 2016).

One major environmental implication of charcoal production is deforestation. The continuous harvesting of trees, particularly preferred hardwood species such as *Terminalia glaucancens*, *Dialium guineense*, *Butyrospermum paradoxum*, and *Tectona grandis* has led to significant reduction in forest cover across many parts of Nigeria. These species are often felled indiscriminately without adequate reforestation efforts, resulting in the gradual depletion of forest reserves. This unsustainable exploitation disrupts ecological balance and reduces the regenerative capacity of forest ecosystems. Closely linked to deforestation is biodiversity loss. Forest ecosystems in Southwestern Nigeria are home to a wide variety of plant and animal species. The removal of key tree species for charcoal production destroys natural habitats, leading to the displacement or extinction of wildlife. The selective harvesting of economically valuable tree species also alters species composition, reducing genetic diversity and weakening ecosystem resilience. Over time, this can lead to ecosystem degradation and loss of important ecological services such as pollination, climate regulation, and nutrient cycling (Ogunsanwo et al., 2007). Another critical concern is the contribution of charcoal production to carbon emissions and climate change. The process of carbonization using traditional kilns is inefficient and releases significant amounts of carbon dioxide (CO_2), methane (CH_4), and other greenhouse gases into the atmosphere. In addition, deforestation reduces the number of trees available to absorb atmospheric carbon,

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thereby increasing the net concentration of greenhouse gases. This dual effect—emissions from production and reduced carbon sequestration—contributes to global warming and climate variability.

Furthermore, charcoal production contributes to land degradation and soil erosion. The removal of tree cover exposes the soil to direct sunlight and rainfall, reducing soil fertility and increasing susceptibility to erosion. This negatively affects agricultural productivity and threatens the livelihoods of rural communities that depend on land resources. Despite its economic benefits, the largely informal nature of charcoal production makes it difficult to monitor output and enforce sustainable practices. The lack of reliable data on production levels (Salamatu et al., 2025) further complicates efforts to design effective environmental policies. The preference for certain high-quality species, driven by factors such as wood density, burning efficiency, and calorific value, leads to their overexploitation (Ekpo & Mba, 2020), increasing the risk of long-term resource depletion. Given the growing demand for charcoal and its associated environmental implications, there is a need for sustainable management practices such as regulated harvesting, afforestation, adoption of improved kiln technologies, and promotion of alternative energy sources. Understanding the tree species utilized and the scale of charcoal production will provide critical insights into forest resource use patterns and help mitigate the adverse environmental impacts associated with charcoal production. it is essential to understand the tree species utilized and the scale of charcoal production within specific regions. Assessing the types of tree species used and the annual output of charcoal production will provide useful insights into patterns of forest resource utilization and the potential environmental impacts associated with charcoal production. Therefore, the study provides answers to the following research questions:

i. What are the socio-economic characteristics of charcoal producers in southwestern, Nigeria?
ii. What are the types of tree used for charcoal production and the quantity of charcoal produced per annum?
iii. What are the factors that influence charcoal production?
iv. What are the constraints hindering methods used to manage hazards associated with charcoal production?

OBJECTIVES OF THE STUDY

i. describe the socio-economic characteristics of charcoal producers.
ii. identify the types of trees used for charcoal production and the quantity of charcoal produced per annum.
iii. investigate the factors that influence charcoal production.

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iv. assess the constraints hindering methods used to manage hazards associated with charcoal production.

HYPOTHESIS OF THE STUDY

The hypothesis of the study was stated in null form as follows:

HO_1: There is no significant difference in quantity of charcoal produced per annum across the three states in the southwestern, Nigeria.

RESEARCH METHODOLOGY

The study was conducted in the Southwestern geopolitical zone of Nigeria, comprising Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti States. The zone lies within the equatorial rainforest belt with temperatures ranging from 21°C to 34°C and annual rainfall between 1500 mm and 3000 mm (Faleyimu et al., 2013). It has a distinct wet season from April to October and a dry season from November to March. Humidity is high between July and December and low between December and February (Faleyimu et al., 2013). The major occupation of the people is farming, which is largely rain-fed and semi-commercial in nature. The climate is tropical, characterized by alternating wet and dry seasons (Faleyimu et al., 2010). The wet season is influenced by the southwest monsoon from the Atlantic Ocean, while the dry season is influenced by the northeast trade wind from the Sahara Desert. Vegetation consists of freshwater swamp and mangrove forests, with lowland forests extending inland to Ogun and parts of Ondo State. Oyo, Osun, and Ogun States were purposively selected due to the prominence of charcoal production in the area. The questionnaire was pre-tested on 25 charcoal producers, and ambiguous or unclear items were revised or removed. Validity was ensured through expert review by professionals in Agricultural Extension and Rural Development. Necessary corrections were made to improve content and face validity of the instrument. Reliability was tested using test–retest method, yielding a Pearson correlation coefficient of 0.80, indicating the instrument was reliable. A multistage sampling technique was used to select both registered and non-registered charcoal producers.

Stage 1: Oyo, Osun, and Ogun States were purposively selected due to their prominence in charcoal production. The study area comprised eleven agricultural zones and eighty-three extension blocks.

Stage 2: Fifty percent of the agricultural zones were randomly selected, resulting in six zones. Three extension blocks were randomly selected from each zone, making eighteen blocks. Two extension cells were selected from each block, giving a total of thirty-six cells.

Stage 3: A total of 989 registered charcoal producers formed the sampling frame. Twenty percent of the registered producers were selected, resulting in 198 respondents.

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Snowball sampling was used to identify non-registered producers, from which 20% (182) were selected. Overall, a total sample size of 381 charcoal producers was used for the study.

RESULT AND DISCUSSION

Age: The study revealed that 64.57% of charcoal producers were between 36–45 years, while 17.84% were within the 26–35 age group. Additionally, 11.02% were above 55 years, and 6.56% were 25 years or younger. The average age of respondents across the selected states was 42 years. These findings indicate that most charcoal producers in the study area are within the mature, energetic, and economically active age group. This suggests a high potential for skill acquisition and the adoption of improved practices. The result aligns with Eniola et al. (2016), which reported that charcoal production is largely dominated by individuals aged 36–45 years.

Sex: A significant majority (80.83%) of respondents were male, while only 19.16% were female. This indicates that charcoal production is a male-dominated activity, likely due to its physically demanding nature. This observation is consistent with findings by SEI (2002) and CHAPOSA (2002), which reported that the majority of charcoal producers—70% in the case of South Africa—were men.

Marital Status: As shown in Table 1, the majority of respondents (67.19%) were married, 26.50% were single, 3.67% were divorced, and 2.62% were widowed or separated. This suggests a strong adherence to marital norms within the study area. Marital status can influence production levels, as married individuals often bear greater family responsibilities, which may drive the need for increased income and involvement in charcoal production. This finding aligns with Olujobi (2015), who reported that more than half of his respondents were married. The high percentage of married respondents also implies a potential increase in household labor supply, as family needs may prompt engagement in income-generating activities like charcoal production.

Years of Experience in Charcoal Production: As shown in Table 4, 38.06% of respondents had 11–15 years of experience in charcoal production, while 24.67% had 5–10 years, and 21.00% had 16–20 years of experience. A small percentage (3.15%) had fewer than 5 years of experience. The average number of years spent in charcoal production among respondents was 14 years. This suggests that most producers have considerable experience, which may enhance their ability to manage production risks and mitigate health or environmental hazards. These findings align with those of Bada et al. (2009), who reported that charcoal producers in Southwestern Nigeria typically have between 5 and 19 years of experience.

Household Size: also, below average (46.72%) of the respondents had between 5-10 members in their household, 38.85% had above 10 members in their household while 14.44% had less than five 5 members in their household. The mean household size in the study area was revealed to be

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9 members. This result is an indication that southwestern people have a fairly large household size and this might be attributed to the dominance of charcoal production in the zone which influences the respondents to have more members in their household to shoulder the responsibility of charcoal production labour. Bada *et al.* (2009) in a related study reveal that most charcoal producers have household size of between 6 and 10 which has positive implications on the family labour availability for charcoal production which increase their production.

Annual Income from Charcoal Production: The results indicate that 41.21% of respondents earned between ₦250,001 and ₦500,000 annually from charcoal production, while 31.76% earned up to ₦250,000. Additionally, 24.15% reported annual earnings ranging from ₦500,001 to ₦1,000,000, and only a small proportion (2.85%) earned above ₦1,000,000. The mean annual income from charcoal production was ₦425,866.10. These findings suggest that charcoal production constitutes a significant source of livelihood and plays an important role in the local economy. This is consistent with the findings of Inoni (2009), who observed that the majority (77%) of rural households in Nigeria are low-income earners, relying on subsistence farming, livestock rearing, and forest-based activities such as charcoal production.

Years of Experience in Charcoal Production: As shown in Table 4, 38.06% of respondents had 11–15 years of experience in charcoal production, while 24.67% had 5–10 years, and 21.00% had 16–20 years of experience. A small percentage (3.15%) had fewer than 5 years of experience. The average number of years spent in charcoal production among respondents was 14 years. This suggests that most producers have considerable experience, which may enhance their ability to manage production risks and mitigate health or environmental hazards. These findings align with those of Bada et al. (2009), who reported that charcoal producers in Southwestern Nigeria typically have between 5 and 19 years of experience.

Table 1: Socioeconomic characteristics of charcoal producers in the study area

Variables	Frequency	Percentage	Mean
Age (Years)		39yrs	
< 25	25	6.56	
25 – 35	68	17.84	
36 – 45	246	64.57	
> 55	42	11.02	
Sex			
Male	308	80.83	
Female	73	19.16	
Marital Status			
Married	256	67.19	
Single	101	26.50	

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Divorced	14		3.67
Widowed/Separated	10		2.62
Years spent in school		11yrs	
0	48		12.60
1 – 6	123		32.28
7 – 12	203		12.60
>12	7		1.84
Household size		9	
< 5	55		14.44
5 – 10	178		46.72
> 10	148		38.85
Average annual income from charcoal production (N)		445,866.10	
< 250,000	121		31.76
250,001 – 500,000	157		41.21
500,001 – 1,000,000	92		24.15
> 1,000,000	11		2.85
Years of experience in charcoal production		14yrs	
< 5	12		3.15
5 – 10	94		24.67
11 – 15	145		38.06
16 – 20	80		21.00
> 20	50		13.12
Total	**100**		**381**

Source: Field survey, 2025

The result in Table 2 shows the hardwood tree species used for charcoal production in the study area. The Weighted Mean Score (WMS) was used to measure the relative importance and perception of variables based on respondents' ratings. It's assigns weights to each response and generates a single mean score for each item. *Terminalia glaucescens* (Idi) with a WMS of 1.66 ranked 1st, followed by *Dialium guineense* (Ayin) with a WMS of 1.65 ranked 2nd. *Butyrospermum paradoxum* (Emi) with a WMS of 1.60 ranked 3rd, while *Tectona grandis* (Gedu) with a WMS of 1.52 ranked 4th. Also, *Azadirachta indica* (Dongoyaro) with a WMS of 1.48 ranked 5th, *Distemonanthus benthamianus* (Ayan) with a WMS of 1.34 ranked 6th, and *Swietenia macrophylla* (Mahogany) with a WMS of 0.96 ranked last. The result implies that respondents predominantly used *Butyrospermum paradoxum*, *Dialium guineense*, *Terminalia glaucescens*, and *Azadirachta indica* for charcoal production due to their hardwood characteristics, which produce dense, high-quality charcoal with high calorific value. This finding agrees with Adeniji et al.

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(2015). Furthermore, the result shows the distribution of respondents on the use of softwood species for charcoal production. *Mangifera indica* (Mango) ranked 1st with a WMS of 1.55, followed by *Parkia biglobosa* (Igba) with a WMS of 1.47 ranked 2nd. *Delonix regia* (Flamboyant) with a WMS of 1.22 ranked 3rd, *Acacia* spp. with a WMS of 1.04 ranked 4th, *Daniellia oliveri* (Iya) with a WMS of 0.80 ranked 5th, and *Anacardium occidentale* (Cashew) with a WMS of 0.75 ranked last. The result indicates that respondents used softwood species such as *Mangifera indica*, *Parkia biglobosa*, *Delonix regia*, *Daniellia oliveri*, and *Anacardium occidentale* as alternatives when hardwood species are scarce. This finding is consistent with Eniola et al. (2018), who reported that these softwood species are commonly used domestically for charcoal production despite the higher demand and economic value of hardwood species in Nigeria.

Table 2: Types of tree varieties used for charcoal production in Southwestern Nigeria.

Tree varieties used Pooled (n=381)	**Frequency of usage**				
Hard Wood	**A**	**O**	**NA**		
	F(%)	**F(%)**	**F(%)**	**WMS**	**Rank**
Terminalia glaucescens (Idi)	290(76.12)	54(14.17)	37(9.71)	1.66	1st
Dialium guineense (Ayin)	269(70.60)	93(24.21)	19(4.99)	1.65	2nd
Butyrospermum paradoxum (Emi)	275(72.18)	58(15.22)	48(12.60)	1.60	3rd
Tectonia grandis (Gedu)	240(62.99)	99(25.98)	42(11.02)	1.52	4th
Azadirachta indica (Dongoyaro)	22659.32)	112(29.40)	43(11.29)	1.48	5th
Distemonanthus benthamianus (Ayan)	171(44.88)	167(43.83)	43(11.29)	1.34	6th
Swietenia macrophylla (Mahogany	123(32.28)	118(30.97)	140(36.75)	0.96	7th
Soft Wood	**A**	**O**	**NA**		
	F(%)	**F(%)**	**F(%)**	**WMS**	**Rank**
Mangifera indica (Mango tree)	255(66.93)	81(21.26)	45(11.81)	1.55	1st
Parkia Biglobosa (Igbaa)	215(56.43)	128(33.60)	38(9.97)	1.47	2nd
Delonix regia (panseke)	209(54.86)	45(11.81)	127(33.33)	1.22	3rd
Acacia spp (cassia tree)	151(39.63)	93(24.41)	137(35.96)	1.04	4th
Daniella Olivera (iyaa)	93(24.41)	118(30.97)	170(44.62)	0.80	5th
Anacardium occidentale (Cashew)	85(22.31)	114(29.92)	182(47.77)	0.75	6th

Source: Field Survey, 2025 Note: A- Always used, O- Occasionally used, NA- Not used at all

Quantity of charcoal produced per annum for the year 2022, 2023 and 2024. (n=381)

The distribution of respondents (charcoal producers) based on the quantity of charcoal produced per kilogram per annum for years 2022, 2023 and 2024 across the study area was presented in Table 3. The Weighted Mean Score was calculated and rank accordingly. The result revealed the mean charcoal produced for 2022 in southwestern, Nigeria was 167, 115.73kg while Oyo state

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producers accounted for 178,560.90kg. Osun state and Ogun state accounted for 101,480.10kg and 155,670.55kg of charcoal produced respectively. This result implies that charcoal is produced in large quantities in the south west region. The result is in line with the findings of CHAPOSA (2002) who reported that average charcoal produced across rain forest (parts of Oyo, Osun, and Ogun state) and derived savannah (parts of Oyo state, Oke Ogun) is between 80,000kg-200,000 kg of charcoal per annum, hence an affirmation that southwestern Nigeria is major producers of charcoal. For year 2023, the average charcoal produced for the three selected states Oyo accounted for 64,600.15kg, Osun accounted for 65,670.70kg and Ogun accounted for 70,550.56kg while the grand mean across the study location is estimated at 66,940.54kg. This negate the apriori expectation and finding of CHAPOSA (2002) that average charcoal produced across rain forest (parts of Oyo, Osun, and Ogun state) and derived savannah (parts of Oyo state, Oke Ogun) is between 80,000kg-200,000 kg of charcoal per annum. Furthermore, the results as presented in Table 3 revealed that the mean charcoal produced in Oyo, Osun and Ogun for year 2024 and it was estimated at 118,210.78kg, 102,890.11 and 95,770.90kg respectively while the grand mean across the study location was estimated at 105,623.93kg. This result was in conformity with CHAPOSA, (2002) who reported that average charcoal produced across rain forest (parts of Oyo, Osun, and Ogun state) and derived savannah (parts of Oyo state, Oke Ogun) is between 80,000kg-200,000 kg of charcoal per annum. Also, SEI (2002) revealed that high quantity of charcoal is only possible in the rainforest zone and this was found in the study area.

Table 3: Quantity of charcoal produced for the year 2022, 2023 and 2024 in the study area.

Kilogram of Charcoal	**Oyo (155)**		**Osun (n=101)**		**Ogun (n=125)**		**Pooled (n=381)**	
Qty per annum	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Year 2022								
35 – 35000	5.00	3.23	4.00	3.96	2.00	1.60	11.00	2.89
35001 – 65000	9.00	5.81	23.00	22.77	12.00	9.60	44.00	11.55
65001 – 95000	12.00	7.74	3.00	2.97	7.00	5.60	22.00	5.77
95001 – 12000	22.00	14.19	43.00	42.57	14.00	11.20	79.00	20.73
120001 – 150000	8.00	5.16	8.00	7.92	10.00	8.00	26.00	6.82
150001 – 180000	12.00	7.74	11.00	10.89	52.00	41.60	75.00	19.69
Above 180000	87.00	56.13	9.00	8.91	28.00	22.40	124.00	32.55
Mean	**178,560.90**		**101.480.10**		**155,670.55**		**167,115.73**	
Year 2023								
35 – 35000	29.00	18.71	17.00	16.83	19.00	15.20	65.00	17.06
35001 – 65000	67.00	43.23	31.00	30.69	12.00	9.60	110.00	28.87
65001 – 95000	12.00	7.74	28.00	27.72	40.00	32.00	80.00	21.00
95001 – 12000	22.00	14.19	9.00	8.91	14.00	11.20	45.00	11.81

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120001 - 150000	8.00	5.16	5.00	4.95	8.00	6.40	21.00	5.51
150001 - 180000	12.00	7.74	2.00	1.98	17.00	13.60	31.00	8.14
Above 180000	5.00	3.23	9.00	8.91	15.00	12.00	29.00	7.61
Mean	**64,600.15**		**65,670.90**		**70,550.56**		**66,940.54**	
Year 2024								
35 – 35000	10.00	6.45	4.00	3.96	7.00	5.60	21.00	5.51
35001 – 65000	21.00	13.55	28.00	27.72	35.00	28.00	84.00	22.05
65001 – 95000	25.00	16.13	16.00	15.84	14.00	11.20	55.00	14.44
95001 – 12000	26.00	16.77	21.00	20.79	31.00	24.80	78.00	20.47
120001 - 150000	55.00	35.48	10.00	9.90	15.00	12.00	80.00	21.00
150001 - 180000	13.00	8.39	15.00	14.85	7.00	5.60	35.00	9.19
Above 180000	5.00	3.23	7.00	6.93	16.00	12.80	28.00	7.35
Mean	**118,210.78**		**102,890.11**		**95,770.90**		**105,623.93**	

Source: Field Survey, 2025 F: Frequency %: Percentage

Factors influencing charcoal production in southwestern states of Nigeria. (n=381)

Table 4 presents the factors influencing charcoal production in the study area. The results from the table revealed that charcoal generate additional source of income for the producers and is a major influencing factor influencing charcoal production and it was ranked 1st with (WMS = 1.96). Availability of tree species that is good for charcoal production and material required for charcoal are available locally were jointly ranked 2nd with (WMS = 1.88), material required for charcoal; production are available locally was ranked 3rd with (WMS = 1.87), the respondent also revealed that charcoal production serves as off –farm employment opportunities for them and it was ranked 4th with (WMS = 1.84), high income from the charcoal exportation was a great influence that encourage respondents from producing charcoal was ranked 5th with (WMS = 1.82), it is the cheapest sources of household and industrial energy and monetary returns from charcoal is higher to other arable crop production thereby influence the respondents to charcoal production were jointly ranked 6th with (WMS = 1.78), while high demand for charcoal for cooking in the villages and cities was ranked 8th with (WMS = 1.39). In addition, no special skill required for charcoal production was ranked was ranked 9th with (WMS = 1.26), is serves as security against crop failure ranked 10th with (WMS = 1.23) while cost of purchasing input is cheap compared to farming had the least ranking of 11th with (WMS = 0.89). The result implies that all the aforementioned factors influence charcoal production in the study area. The results in the line with the findings of Akinbami (2011) which revealed that income from charcoal production, availability of good tree species for charcoal production and the cheap production cost of charcoal compared to other farming activities were the reasons while many people were involved production of charcoal in Africa. Also, Baland *et al.* (2004) revealed that poor households with little income earning source for alternatives means of livelihood through production of charcoal.

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Table 4: Factors influencing charcoal production in southwestern states of Nigeria. (n=381)

Factors influencing charcoal production	Highly influenced 2	Moderately Influenced 1	Not influenced 0		
	F(%)	F(%)	F(%)	WMS	Rank
Charcoal generate additional source income	367(96.33)	14 (3.67)	0 (0.00)	1.96	1st
Availability of tree species that are good for charcoal production	334(87.66)	47 (12.34)	0 (0.00)	1.88	2nd
Materials required for charcoal production are available locally	334(87.66)	47 (12.34)	0 (0.00)	1.87	3rd
It serves as off – farm employment opportunity	327(85.83)	46 (12.07)	8 (2.10)	1.84	4th
High income from charcoal exportation	319(83.73)	57 (14.96)	5 (1.31)	1.82	5th
It is the cheapest sources of household and industrial energy	321(84.25)	38 (9.97)	22 (5.77)	1.78	6th
Monetary returns from charcoal is higher compared to other arable crop production	317(83.20)	45 (11.81)	19 (4.99)	1.78	6th
High demand of charcoal for cooking in the villages and cities	156(40.94)	220(57.74)	5 (1.31)	1.39	8th
No special skill is required for charcoal production	118(30.97)	243(63.78)	20 (5.25)	1.26	9th
It serves as security against crop failure	123(32.28)	221(58.01)	37 (9.71)	1.23	10th
Cost of purchasing input is cheap compared to farming	5 (1.31)	331(86.88)	45(11.81)	0.89	11th

Source: Field Survey, 2025 F: Frequency %: Percentage WMS: Weighed mean score

Constraints hindering methods used to manage hazards associated with charcoal production in southwestern Nigeria. (n=381)

Table 5 presents the constraints hindering methods used to manage hazards associated with charcoal production. The results revealed that unavailability of health care facilities were major constraints identified by the respondents with (WMS = 1.92) and it was ranked 1st, unstable government policy in charcoal production and forest guide was also a major constraints was ranked 2nd with (WMS = 1.91), unpredictable returns from sales and production of charcoal was ranked 3rd with (WMS = 1.87), poor mechanism for evaluating and monitoring of charcoal producers is

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also a constraint mentioned by the respondents which was ranked 4th with (WMS = 1.84), while estimated cost of hazard management with (WMS = 1.83). Also lack of proper management plan by charcoal producers ranked 6th with (WMS = 1.76), customary land tenure and seasonality of products due to insecurity with (WMS = 1.51) were jointly ranked 7th, non-challant attitudes of local residents and charcoal producers was ranked 9th with (WMS = 1.47), charcoal producers' association is not promoting proper risk management among members was ranked 10th with WMS of 1.45. Furthermore, high cost of gloves, breathing filter and farm boots required for protection was ranked 11th with (WMS = 1.39), lack of awareness on improved methods for charcoal production was ranked 12th with (WMS = 1.21). Traditional charcoal production pose problem in hazard management was ranked 13th with (WMS = 1.20), lack of awareness about hazard management among stakeholders was ranked 14th with (WMS = 1.17), people view charcoal production as a means of livelihood was ranked 15th with (WMS = 1.13) while poor hygiene of the charcoal producers and users was ranked 16th with (WMS = 1.20). This corroborates the study of SEI (2012) which emphasizes that unavailability of health care facilities, high cost of gloves, breathing filter and farm boot required for protection during production, poor hygiene of the charcoal producers and lack of awareness on improved method of charcoal production were major constraints hindering methods used to manage hazards associated with charcoal production in Africa.

Table 5: Constraint hindering methods used to manage hazards associated with charcoal production in southwestern, Nigeria. (n=381)

Constraints	Major constraints F(%)	Mild constraints F(%)	Not a constraints F(%)	WMS	Rank
Unavailability of health care facilities	362 (95.01)	8 (2.10)	11 (2.89)	1.92	1st
Unstable government policy on charcoal production and forest guide	361 (94.75)	4 (1.05)	16 (4.20)	1.91	2nd
Unpredictable returns from sales of charcoal	342 (89.76)	28 (7.35)	11 (2.89)	1.87	3rd
Poor mechanism for evaluating and monitoring of charcoal producers	329 (86.35)	48 (12.60)	4 (1.05)	1.85	4th
Estimated cost of hazard management is a major constraints	321 (84.25)	56 (14.70)	4 (1.05)	1.83	5th
Lack of proper management plan by charcoal producers	328 (86.09)	15 (3.94)	38 (9.97)	1.76	6th
Customary land tenure	224 (58.79)	127 (33.33)	30 (7.87)	1.51	7th
Seasonal production nature due to scarcity of trees	264 (69.29)	46 (12.07)	71 (18.64)	1.51	7th

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Non-challant attitude of local residents and charcoal producers	240 (62.99)	80 (21.00)	61 (16.01)	1.47	9th
Charcoal producers association is not promoting proper risk management among members	201 (52.76)	151 (39.63)	29 (7.61)	1.45	10th
High cost of gloves, breathing filter and farm boot required for protection	149 (39.11)	232 (60.89)	0 (0.00)	1.39	11th
Lack of awareness on improved method for charcoal production.	97 (25.46)	268 (70.34)	16 (4.20)	1.21	12th
Traditional charcoal production pose problem in hazard management	183 (48.03)	92 (24.15)	106 (27.82)	1.20	13th
Lack of awareness about hazard management among stakeholders	81 (21.54)	282 (75.00)	13 (3.46)	1.17	14th
People view charcoal production as a means of livelihood	72 (18.90)	286 (75.07)	3 (6.04)	1.13	15th
Poor hygiene of the charcoal producers and users	130 (34.12)	69 (18.11)	182 (47.77)	0.86	16th

Source: Field Survey, 2025. F- Frequency %- Percentage WMS: Weighed mean score

Test of hypotheses of the study

There is no significant difference in quantity of charcoal produce per annum across the study area. (n=381)

The result was achieved using Analysis of Variance (ANOVA) at 0.05 significant level where F = 0.78 and probability is greater than 0.05 level of significance. It revealed that there was no significant difference in the quantity of charcoal produce per annum across the study area. Therefore, the null hypothesis stated is accepted. This implies that charcoal produced across the three states were of similar quantity and this could be related to several factors which include using the same method of charcoal production (earth mound method) and also due to the fact that they used almost the same soft and hard woods for charcoal production amongst other several factors across the study area. This result was in conformity with CHAPOSA, (2002) who reported that average charcoal produced across rain forest (parts of Oyo, Osun and Ogun states) and derived savannah (parts of Oyo states) in Southwestern Nigeria**.**

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Table 6: Summary of Analysis of Variance showing differences in quantity of charcoal produce per annum across the study area (n=381)

Variable	SS	df	MS	F	Prob> F	Decision
Between groups	5678.96	2	1371.63	0.78	0.5601	NS
Within groups	85890.89	379	5690.64			
Total	91569.85	381	7023.84			

NS = Not significant, S= Significant Source: Computed Data, 2025

CONCLUSION AND RECOMMENDATION

This study assessed the tree species utilized and annual output of charcoal production in Southwestern Nigeria, with emphasis on socio-economic characteristics, species preference, influencing factors, and constraints to hazard management. The findings show that charcoal production is dominated by economically active males with considerable experience and relatively large households, underscoring its importance as a livelihood strategy. Hardwood species such as *Terminalia glaucescens*, *Dialium guineense*, and *Butyrospermum paradoxum* were most preferred due to their superior charcoal quality and high calorific value, while production levels remain substantial across Oyo, Osun, and Ogun States. Income generation, availability of tree species, and access to production inputs were key drivers, whereas inadequate healthcare, weak policy enforcement, limited awareness of improved technologies, and high cost of protective equipment constrained effective hazard management. The absence of significant variation in annual output across the states suggests a widespread and relatively uniform dependence on charcoal production in the region. However, this consistency also indicates sustained pressure on forest resources, raising concerns about long-term environmental sustainability, including deforestation, biodiversity loss, and increased carbon emissions. The continued reliance on traditional production methods further exacerbates environmental degradation and exposes producers to health risks. In view of these findings, there is a need for policy interventions that promote sustainable forest management through regulated harvesting, afforestation, and the domestication of fast-growing tree species for energy use. Government and relevant stakeholders should strengthen monitoring frameworks and enforce environmental regulations to curb indiscriminate tree felling. There is also a need to promote the adoption of improved and efficient charcoal production technologies to reduce wood consumption and emissions. Based on the findings of this study, the following recommendations are made:

i. Promotion of Sustainable Forest Management: Government and environmental agencies should promote tree planting and reforestation programmes to ensure sustainable supply of tree species used for charcoal production and reduce the rate of deforestation.

ii. Adoption of Improved Charcoal Production Technologies: Charcoal producers should be encouraged to adopt improved and environmentally friendly charcoal production methods that reduce wood consumption and increase production efficiency.

iii. Strengthening Government Policies and Monitoring: There is a need for effective policies and stronger monitoring mechanisms by relevant authorities to regulate charcoal production activities and prevent excessive exploitation of forest resources.

iv. Capacity Building and Awareness Creation: Training programmes should be organized for charcoal producers to increase their awareness of improved production techniques, hazard management practices, and environmental conservation.

v. Provision of Health and Safety Facilities: Government and relevant stakeholders should facilitate access to healthcare services and affordable protective equipment such as gloves, boots, and breathing filters to reduce health risks associated with charcoal production.

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