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Socioeconomic of Charcoal Producers among Farm Families in Oyo State, Nigeria

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Abstract
Charcoal remains a vital domestic fuel and livelihood source in Oyo State, yet limited research examines its socio-economic benefits for farming households. This study therefore investigates charcoal production, distribution, and use among farm families in Oyo State, Nigeria, to reflect how these activities shape income, energy access, and sustainability. A descriptive survey design and a multi-stage sampling procedure were employed to select 300 respondents from 6,004 farm families. Data were analysed using descriptive and inferential statistics, with significance set at $p < .05$. Most respondents were male (59.6%), married (59.7%), had formal education (41.3%), and belonged to cooperatives (93.5%). Mean age was 40 ± 10 years, household size 10 ± 4, farming experience 9 ± 3 years, charcoal output 29,930 ± 9,930 kg, and monthly income and expenditure were ₦395,000 ± 260,274 and ₦303,333 ± 175,499, respectively. Significant relationships existed between production ($r = -0.305$), distribution ($r = 1.116$), utilisation ($r = 1.389$), and socio-economic contribution. Multiple regression showed age ($\beta = 2.500$), education ($\beta = 0.400$), household size ($\beta = 6.000$), experience ($\beta = 0.700$), and income ($\beta = 1.800$) were significant at $p < .01$; gender ($\beta = 3.200$) and charcoal quantity ($\beta = 1.100$) were significant at $p < .05$ ($R^2 = 0.6100$; $p < .05$). Education, income, experience, and household size significantly shape farm families. Sustainable charcoal production therefore requires addressing these socio-economic factors.

Keywords: Distribution, Education, Livelihood, Sustainable, Utilisation.

1. Introduction

Charcoal remains a central domestic fuel in developing countries, particularly across sub-Saharan Africa, where it is used for cooking, heating, and illumination. Together with firewood and other wood-derived fuels, it constitutes the primary non-fossil household energy source (Oke *et al*., 2022). In Africa, more than 90% of harvested timber is used as wood fuel, much of it burned directly and a substantial proportion converted into charcoal (Amours, 2022). Charcoal is a light black carbon residue produced by heating wood or other plant and animal materials under limited oxygen to remove moisture and volatile components (Daramola & Ayeni, 2016). Although traditional earth kilns remain the dominant production method, briquettes made from crop residues and binders have emerged as alternatives, though their use is still constrained (Mamudu *et al*., 2023; C Borres Jr & Mora, 2022; Sabo *et al*., 2022; Omole *et al*., 2023). The scale of reliance is considerable: over 80% of rural dwellers use charcoal (Ahmed *et al*., 2022), about 2.5 billion people in developing nations depend on biomass for household energy, and in many countries, biomass accounts for more than 90% of household fuel, with demand projected to rise (IEA, 2022).

Beyond domestic consumption, charcoal has significant socio-economic value. In Nigeria, it is produced by individuals, groups, and cooperative societies seeking a cleaner and more convenient hydrocarbon source for domestic and industrial applications (Olawumi *et al.*, 2021). It is transported in vehicles ranging from small cars to large trucks from Southwestern states to Northern and Southeastern states and to neighbouring countries, supporting livelihoods and energy needs (Daniel, 2021). Industrially, charcoal serves as a reducing agent in metallurgical processes (FAO, 2020), while demand as barbecue fuel continues to grow even in advanced economies. Nigeria exported $51.6 million worth of wood charcoal in 2022, with major recipients including Kuwait, the United Arab Emirates, South Korea, Lebanon, and Portugal. Global import leaders include China, Japan, North Korea, the USA, and Germany. Worldwide, more than 40 million metric tonnes of charcoal are used annually, and around 2.4 billion people rely on wood and charcoal for daily energy (FAO, 2023). Nigerian charcoal is favoured in Europe and Asia partly because tropical hardwood provides a slower burn and higher heat, making it an

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economical heating option.

However, charcoal production raises serious sustainability concerns. Traditional kilns typically yield about 60% charcoal by volume, or 25% by weight, while small-scale methods may achieve only about 50% by volume and large-scale approaches up to 90% (Eniola *et al*., 2018). Conventional production also releases pollutants, including unburned methane, with adverse effects on human well-being and ecosystems. Sustainable production therefore depends on effective linkages between production locations and markets, ensuring that charcoal reaches end users efficiently. In Oyo State, key production and export areas include Iseyin, Saki, and Itesiwaju Local Government Areas, with notable depots in Igbo-Ora and Ogbomosho. Yet international charcoal trade is challenging and requires experienced exporters; mismanagement and fraudulent forwarders have caused losses, making registration with the Corporate Affairs Commission and the Nigeria Export Promotion Council essential (NEPC, 2023).

Although prior studies have examined various energy sources and their economic implications (Olawumi et al., 2013), there remains limited understanding of how charcoal production, distribution, and use affect farm families in Oyo State, particularly regarding socioeconomic and environmental trade-offs. This study therefore examines the socioeconomic of charcoal production, distribution, and use among farm families in Oyo State, with a view to informing sustainable energy and livelihood policies.

1.1 Statement of Problem

Wood fuel comprising charcoal, firewood, and other wood derived fuels remains the dominant non-fossil energy source for households and a critical income stream for many rural dwellers (Oke *et al*. 2022). In Oyo State, however, households and enterprises continue to rely heavily on charcoal because access to alternative energy sources such as electricity, liquefied petroleum gas (LPG), and solar power remains limited. This entrenched dependence sharpens the dilemma between charcoal production as a livelihood strategy and its environmental cost, especially tree felling. With growing evidence underscoring the need to reconcile charcoal production with environmental sustainability (Ahmed *et al*. 2022), this study therefore investigates the socioeconomic of charcoal production, distribution, and use among charcoal producers in Oyo State.

1.2 Objective of the Study

The study assessed the socioeconomic benefits of charcoal production, distribution, and use among farm families in Oyo State, Nigeria. The study specifically:

i. Identified and described the socioeconomic attributes of the farming households in Oyo State.
ii. Identified different techniques of charcoal production, channels of distribution, and use of charcoal by the respondents in Oyo State.
iii. Evaluated the socioeconomic benefits of charcoal production, distribution, and use based on the monthly earnings and spending of the farm families in Oyo State.

1. 3 Research Questions

1. What are the socioeconomic characteristics of the respondents in Oyo State?
2. What techniques and channels do the respondents use for charcoal production and distribution in Oyo State?
3. What are the socioeconomic benefits of charcoal production, distribution, and utilisation on the respondents' monthly earnings and spending in Oyo State?

1.4 Hypotheses

The hypotheses were developed and examined in the null format for the research:

$H_{01:}$ There is no significant relationship between the selected socio-economic traits of the charcoal producers and charcoal production, distribution, and utilisation in Oyo State.

$H_{02:}$ There is no significant correlation between the level of quantity value and the socioeconomic benefits of charcoal among charcoal farm families in Oyo State.

2. Methodology

The study was conducted in Oyo State. The state is located in the South West region of Nigeria. It covers approximately 28,454 square kilometres, bordering Kwara State to the North, Osun State to the East, Ogun State to the South, and the Republic of Benin to the West. Agriculture is one of the basic occupations of the people of the state. Oyo State is endowed with natural resources which include extensive fertile soil suitable for agriculture and mineral deposits such as kaolin, aquamarine, and marble. Charcoal can be sourced in a few locations in Ogbomoso, Iseyin, Itesiwaju, Iwajowa and Oriire Local Government Areas in Oyo State. The climate and soil of the state are suitable for the cultivation of a wide range of food crops, which include rice, maize, cassava, yam and banana, and cash crops which include cocoa, cashew, citrus, palm oil and palm kernels. Oyo State is one of the largest producers of cassava, maize, cashew, and palm oil on a large scale. There are thirty three (33) Local Government Areas (LGAs) in the State, and Oyo State Agricultural Development Project (OYSADEP) is subdivided into four (4) agricultural zones, namely Ibadan, Oyo, Ogbomoso and Saki (Oyo State Diary, 2024).

The survey research design was adopted for this study in the form of a well-structured questionnaire, and oral interviews were used to elicit information from charcoal producers and traders in Oyo State. Socioeconomic Contribution of Charcoal Production, Distribution and Utilisation Questionnaire (SCCPDUQ) was divided into five parts, A to E. The instrument was face-validated by three experts, made up of two lecturers from the Department of

Table 1a: Socioeconomic Characteristics of Charcoal Producers in Oyo State

Variables	Frequency	Percentage	Mean	SD
Age (years)			40	10
20 - 29	56	18.6		
30 - 39 56	56	18.6		
40 - 49	150	50		
50 – 59	32	10.6		
> 60 years	6	2.0		
Sex				
Male	179	59.6		
Female	121	40.4		
Marital status				
Single	91	30.3		
Married	179	59.7		
Divorced	20	6.7		
Widowed	10	3.3		
Educational status (years)			8	3
No Formal	40	13.3		
Primary	108	36.0		
Secondary	124	41.3		
Tertiary	28	9.3		
Religion				
Christianity	165	55		
Islam	125	41.7		
Traditional	10	3.3		
Household size (persons)			9	4
0 - 5	74	24.7		
6 - 10	155	51.7		
11 – 15	58	19.3		
>15	13	4.3		

Source: Field Survey (2024)

Agricultural Economics and Extension, Tai Solarin Federal University of Education, Ijagun, Ogun State, and one lecturer from the Department of Renewable Resources, University of Ibadan, Oyo State. The reliability of the instrument was determined by administering the questionnaire to charcoal producers and traders in Odeda, Ogun State, which was outside the study area. The data generated were analysed using the Cronbach alpha reliability test, resulting in a reliability coefficient of 0.75. A multi-stage sampling method was used to select 300 respondents. Firstly, the state was divided into four Agricultural Development Project Zones based on the abundance of charcoal production in the area. In the second stage, a simple random sampling technique was used to select four Local Government Areas known for charcoal production based on accessible official reports. In the third stage, the proportionate sampling method was employed to select 5% of the registered charcoal-producing farm families.

Data were analysed using descriptive statistics such as mean and standard deviation, frequency counts and percentage to describe the socioeconomic characteristics of charcoal producers, traders and utilisers, level of socioeconomic impact was accessed using their mean scores, value above the mean is high and the below mean is low. The results of different techniques of charcoal production were measured on three Likert scales of Always (2), Rarely (1), and Never (0), where individual mean scores were used for ranking and decision-making. Inferential statistics such as Pearson Product Moment Correlation (PPMC) and Chi-Square were used to test the hypotheses of the study.

3. Results

Results in Table 1(a and b) show that the average age of the farm families was 40±10 years, with a majority (59.6%) being male. This highlights the prevalence of males over females in charcoal production. A significant portion of the respondents were single (30.3%), married (59.7%), divorced (6.7%), and widowed (3.3%). The mean years of education was 8±3, the household size averaged 9±4 members, and experience stood at 10±6 years. These findings indicate that the charcoal producers in the studied area were educated, had larger households, and possessed more years of experience in charcoal production. The mean output was 24,369±13,213 kg, suggesting that many respondents increased their charcoal production, possibly due to rising demand as gas and kerosene prices continue to rise steeply.

The mean monthly earnings and outgoings were N395,000±260,274 and N303,333±N175,499, respectively. The significance of these average figures from the output, income, and expenses clearly indicated that the respondents gained higher profits from charcoal enterprises. Charcoal production has greatly enhanced the socioeconomic conditions and quality of life for the participants in Oyo State. It was

Table 1b: Socioeconomic Characteristics of Charcoal Producers in Oyo State

Variables	Frequency	Percentage	Mean	SD
Years of experience			10	6
1 - 9 years	151	50.3		
10 – 19 years	130	43.3		
> 20 years	19	6.4		
Charcoal Output (kg)			24,369	13,213
1,000 - 15,000	96	32.0		
15,001 - 30,000	83	27.6		
30,001 – 45,000	110	36.7		
Monthly Income (₦)			395,000	260,274
< 250,000	102	34		
250,001 - 500,000	106	35.3		
500,001 - 750,000	70	23.3		
750,001 – 1,000,000	14	4.7		
> 1,000,001	8	2.7		
Monthly Expenditure (₦)			303,333	175,499
< 250,000	128	42.7		
250,001 - 500,000	131	43.7		
500,001 - 750,000	40	13.3		
750,001 – 1,000,000	1	0.3		
> 1,000,001	0	0		
Cooperative Membership				
Not a member	8	2.7		
Floor Member	286	95.3		
Executive member	6	2.0		
Contact with Forestry Agents			3	2
1 – 5 times monthly	8	71.3		
6 – 10 times monthly	286	26.7		
> 10 times monthly	6	2.0		

Source: Field Survey (2024)

Table 2: Mean Ranking of Techniques for types of ovens used in Charcoal Production

Items	Mean	SD	Rank
Earth mound kiln	2.693	0.600	1st
Earth pit kiln	2.613	0.564	2nd
Metal kiln	2,387	0.725	3rd
Use of drum	2.313	0.724	4th
Improved kiln	1.653	0.842	5th
Charcoal machines	1.393	0.753	6th

Source: Field survey (2024)

observed that a large majority (95.3%) were affiliated with cooperative societies, while 2.7% were not members of cooperatives but participated in other social groups to gain access to funding and to be acknowledged by the government and other international organisations involved in charcoal businesses. The average frequency of contact with forestry agents was 3±2 times each month, suggesting that forestry agents were also utilised to track the actions of charcoal producers and furnished them with essential details regarding the impacts of deforestation and the necessity for increased tree cultivation.

Table 2 indicate the different techniques utilised by the respondents for charcoal production in Oyo State, which were assessed and prioritized based on their average values. These methods encompass earth mound kiln (1st), earth pit kiln (2nd), metal kiln (3rd), use of drum (4th) and improved kiln (5th) while charcoal making machines (6th). This suggests that most of the respondents in Oyo State continue to rely more on earth mounds and earth pits rather than on upgraded kilns and charcoal.

Result in Table 3 reveals the differences in the monthly income and expenditure of the respondents in the study. A few numbers of the respondents (4.7%) earned between ₦750,001 – ₦1,000,000 as a monthly income, whereas only 0.3% of respondents reported spending that amount as monthly expenses. A minimal percentage of the respondents (2.7%) earned more than ₦1,000,001 in monthly earnings, and 0% of respondents allocated that amount of funds as monthly spending. This suggests that the majority of respondents in Oyo State generated substantial profits while incurring lower costs in charcoal enterprises. Respondents with elevated expenditures may be associated with larger family sizes and additional payments for labour and transportation fees.

Table 3: Breakdown of Charcoal Producers' Monthly Income and Expenses

Monthly income in Naira	Income		Expenditure	
	Frequency	Percentage	Frequency	Percentage
<₦250,000	102	34.0	128	42.7
₦250,001 - ₦500,000	106	35.3	131	43.7
₦500,001 - ₦750,000	70	23.3	40	13.3
₦750,001 – ₦1,000,000	14	4.7	1	0.3
>₦1,000,001	8	2.7	0	0
Total	300	100.0	300	100.0
Min	<₦110,000		<₦70,000	
Max	>₦1,500,500		>₦1,000,000	
Mean	395,000		303,333	
SD	260,274		175,499	

Source: Field Survey (2024)

Table 4: Chi-square Examination of Selected Socioeconomic Characteristics among the Respondents

Variables	χ^2 value	p value	Decision
Age	1.06	0.018	S
Sex	2.04	0.025	S
Educational status	0.93	0.014	S
Household size	-1.37	0.012	S
Years of experience	1.44	0.018	S
Monthly income	2.46	0.016	S
Monthly expenditure	0.96	0.019	S
Cooperative membership	1.38	0.021	S
Charcoal Output	2.36	0.023	S
Contact with forest agents	2.27	0.026	S

Source: Field research (2024). Significant at p<.05(S=significant; NS = Not significant)

Table 5: Correlation Result of Charcoal Production and Level of Quantity Value Contribution among Respondents

Variable	r value	p value	Decision
Charcoal production	-0.305	0.014	S
Charcoal distribution	1.116	0 009	S
Charcoal Utilisation	1.389	0.013	S

Source: Field survey (2024) Significant at p<0.05

Table 6: Levels of Socioeconomic Impact of Charcoal Business among Respondents

Level	Frequency	Percentage	Minimum	Maximum	Mean	SD
Low (10-62.4)	123	41.0	10	125	70.15	28.35
High (62.5-125)	177	59.0				
Total	300	100.0				

Source: Field survey (2024)

The findings from the chi-square analysis displayed in Table 4 indicated that there was a meaningful connection between the age of respondents (χ^2=1.06, p<.05), educational status (χ^2=0.93, p<.05), household size (χ^2=-1.37, p<.05), years of experience (χ^2=1.44, p<.05), monthly income (χ^2=2.46, p<.05), charcoal output (χ^2=2.36, p<.05), monthly expenditure (χ^2=0.96, p<.05), members of cooperative (χ^2=1.38, p<.05) and the socioeconomic benefits of charcoal in the region. However, there was no notable correlation between the gender of respondents (χ^2=2.04, p<.05) and contact with forestry agents (χ^2=2.27, p<.05) in Oyo State. This suggests that the age of respondents, level of education, size of household, years of experience, monthly earnings, monthly spending, charcoal production, and cooperative membership were significantly and positively correlated in Oyo State.

Table 5 demonstrated that a noteworthy relationship was found among respondents' feedback on charcoal production (r=-0.305, p<0.03), charcoal distribution (r=1.116, p<0.009), charcoal utilisation (r=1.389, p<0.013), and the socioeconomic benefits of charcoal in Oyo State. This suggests that there is a significant and positive correlation between charcoal production, distribution, and utilisation within the study area. It can also be clarified that the charcoal business is a highly profitable and advantageous venture in the region.

Table 6 indicated the categorisation of socioeconomic contributions related to charcoal production, revealing that a minority of respondents (41%) believed the socioeconomic impact of charcoal production was low, whereas (59%) thought it was high in the study area. The low socioeconomic contribution associated with charcoal production may be attributed to respondents utilising traditional methods, which may lead to

Table 7: Average Ratings of Charcoal Distribution Channels

Items	Mean	SD	Rank
Companies and industries	2.667	0.651	1st
By truck	2.457	0.751	2nd
By government	2.447	0.750	3rd
Normal market settings	2.387	0.795	4th
By container truck	2.377	0.635	5th
Through individual	2.360	0.832	6th
Cooperative societies	2.353	0.724	7th
By mini truck	2.000	0.567	8th
By pickup	1.790	0.821	9th
By registered agencies	1.780	0.829	10th

Source: Field survey (2024)

Table 8: Average Ratings on Utilisation of Charcoal

Items	SA	A	D	SD	Mean	SD
Charcoal is used for household energy	142 (47.3)	140 (46.7)	14 (4.7)	4 (1.3)	3.4	0.64
For spiritual protection	160 (53.4)	92 (30.8)	26 (8.6)	22 (7.2)	3.3	0.91
Addition with medicinal herbs	70 (23.4)	99 (33.1)	66 (21.8)	65 (21.7)	2.58	1.07
For decoration or beautification	107 (35.7)	117 (39.1)	48 (16.0)	28 (9.2)	3.01	0.94
For metallurgical fuel	118 (39.4)	94 (31.4)	50 (16.6)	38 (12.6)	2.97	1.03
Useful in trado-medicines	144 (48.0)	125 (40.8)	23 (7.7)	8 (2.5)	3.35	0.74
Most reliable livelihood activity	108 (36.0)	102 (34.0)	49 (16.2)	41 (13.8)	2.92	1.03
Useful for a blacksmith's forge	183 (60.9)	94 (31.4)	14 (4.6)	9 (3.1)	3.5	0.72
It is used as a black pigment	115 (38.6)	116 (38.5)	47 (15.5)	22 (7.4)	3.08	0.91
Useful to cosmetology	122 (40.6)	106 (35.4)	53 (17.8)	19 (6.2)	3.1	0.91
Useful in archaeology	103 (34.2)	114 (38.0)	47 (15.8)	36 (12.0)	2.95	0.99
Useful as a filter, catalyst, or absorbent	136 (45.4)	113 (37.7)	30 (10.0)	21 (6.9)	3.21	0.89
Production of certain medications in pharmacy	84 (27.7)	99 (33.1)	65 (21.8)	52 (17.4)	2.72	1.05
Useful for cooking	184 (61.2)	116 (38.8)	0 (0.0)	0 (0.0)	3.61	0.49
Useful in blacksmithing	137 (45.5)	132 (44.0)	17 (5.7)	14 (4.8)	3.31	0.78

Source: Field study, 2024. Note: % in parentheses (Average >2.5)
SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree

incomplete combustion of wood and reduced efficiency, resulting in lower charcoal yields and income. Additionally, it is worth noting that the charcoal industry has significantly enhanced the socio-economic conditions for most respondents in the study area.

Table 7 indicates the methods of charcoal distribution utilised by the respondents in the study area, ranked based on their average values. These methods encompass companies and industries (1st), by truck (2nd), by government (3rd), through typical market conditions (4th), by container truck (5th), through individuals (6th), through cooperative societies (7th), by mini-truck (8th), by pickup (9th), and by registered agencies (10th). This indicates that all respondents in Oyo State utilised various avenues for distributing their charcoal, and it is noteworthy that trucks and industries/companies are the primary channels for charcoal distribution.

The findings in Table 8 illustrate different methods of utilising charcoal employed by the respondents in the study area and were evaluated based on their average values. These include charcoal being used for household energy (3.40) and for spiritual protection (3.30), addition with medicinal herbs (2.58), for decoration or beautification (3.01), as metallurgical fuel (2.97), useful in trado-medicines (3.35), most reliable livelihood activity (2.92), useful for blacksmith's forge (3.50), used as black pigment (3.08), useful to cosmetology (3.10), useful in archaeology (2.95), useful as filter catalyst or absorbent (3.21), production of certain medications in pharmacy (2.72), and useful for cooking and heating (3.61) while also useful in blacksmithing (3.31). This indicates that all respondents in the study area employed the use of charcoal in various ways, especially as most of the respondents used charcoal for cooking, blacksmithing purposes, and household energy.

4. Discussion

The research indicated that the socioeconomic traits of agricultural families in Oyo State Nigeria, revealed that

the majority of respondents were males in their economically active years. The marital status distribution showed that a large proportion were married, while others were single, divorced, or widowed. Furthermore, the findings revealed that the average educational attainment was moderate, with respondents having larger household sizes and possessing considerable years of experience in charcoal production. These findings imply that the charcoal producers within Oyo State were educated, had larger family units, and possessed greater experience in charcoal production. The average output was substantial, with mean monthly income exceeding mean monthly expenditure, indicating significant profitability. This discovery aligns with the research of Abenga *et al*. (2022) on obstacles to efficient communication between extension agents and smallholder farmers in Gwagwalada Area Council, Abuja, Nigeria, which indicates that the socio-economic traits and income of farmers play a significant role in influencing farm productivity. This finding corroborates Olawumi *et al.* (2021), who reported that a greater number of male farmers are involved in forest timber products in comparison to female farmers who participate in non-forest timber products. Omole *et al.* (2023) discovered that age had a positive correlation with being a full-time charcoal producer, while the educational attainment of the spouse, engagement in tree planting, annual income from alternative sources, access to credit, and the producer's level of education were all negatively correlated with being a full-time charcoal producer. This outcome supports the discovery made by Olawumi *et al*. (2013), revealing that numerous agricultural families generate their revenue and means of living by engaging in the chewing stick trade. Oke *et al*. (2022) discovered that rural households with a more advanced education, greater years of farming experience, and fewer members tend to be more successful compared to those with larger household sizes. This outcome contradicts the results of Adeloju *et al*. (2020), who indicated that farmers with a greater number of household members will have sufficient support from their family to help with their agricultural tasks. Furthermore, this outcome aligns with the results obtained by Alemayehu *et al.* (2023) that the quality of life is anticipated to enhance as income rises and profits grow, and it concurs with the conclusions of Ahmed *et al.* (2022) that affiliation with farmers' unions or community organisations is the simplest method to access loans and financial aid. This result aligns with the conclusions of Yusuf *et al*. (2020) that effective enforcement of forestry policies could solely be assured by forest rangers and other officials from the government.

The research revealed the different techniques utilised by the farm families for charcoal production in the examined region, which were evaluated and ranked according to their usage frequency. The findings indicated that traditional methods such as earth mound kilns and earth pit kilns were the most predominantly used, followed by metal kilns and the use of drums, while improved kilns and charcoal making machines were the least adopted. This result aligns with the conclusions drawn by Abiola and Olaopa (2018) regarding the economic advancement and the democratic maintenance of forests and their resources in Nigeria, who discovered that earthen mound kilns and earthen pit kilns were frequently utilised techniques for charcoal production in rural regions. This outcome reinforces the observations made by Ihinmikaiye *et al.* (2022), indicating that earth mounds and pit kilns are predominantly employed in local charcoal production, contributing to environmental contamination, whereas enhanced kilns and charcoal production equipment have been utilised for industrial charcoal generation with a reduced environmental impact. This observation aligns with the conclusions of the International Energy Agency (2022), which state that industrial sectors are progressively dominated by charcoal production through mechanised methods for increased output sold in international markets, and is consistent with the results of the World Energy Council (2020) regarding industrial charcoal production practices and energy sources used by rural households. Specifically, this observation aligns with previous studies conducted by Adebayo *et al*. (2019), which revealed that charcoal producers utilising advanced kilns and equipment generate higher profits, even with fewer workers, as these enhanced kilns operate more rapidly, conserve time, and lessen environmental pollution.

The research uncovered different methods of charcoal distribution utilised by the farm families in Oyo State, which were evaluated based on their usage frequency. The findings revealed that distribution through corporations and industries, by truck, and through government channels were the most common, while distribution via registered agencies was the least common. These results align with the conclusions of Adelaja and George (2019) regarding the impact of conflicts on the distribution of wood products among charcoal producers, using evidence from the Boko Haram insurgency; they discovered that charcoal businesses were more active in distributing charcoal products on both a local and global scale. This conclusion is consistent with the findings of Eniola *et al.* (2018) that every aspect of the charcoal industry is lucrative, whether in production, distribution, or utilisation. However, this conclusion contradicts the assertion made by the World Energy Council (2020) that while charcoal enterprises are indeed profitable, they are equally harmful to deforestation and land degradation.

The research uncovered different methods of using charcoal employed by the farming families in the examined region, which were assessed based on the level of agreement or frequency of use. The findings indicated that charcoal was most commonly utilised for domestic energy, spiritual safeguarding, and as metallurgical fuel. Other uses such as cosmetology, archaeology, and pharmaceutical production recorded lower levels of agreement. This discovery supports the

results of Akinbode and Hamzat (2017), who revealed that charcoal is primarily utilised for domestic energy, spiritual safeguarding, medicinal herbs, and ornamental uses in the eastern region of Nigeria. This outcome aligns with the observations of Daniel (2021), noting that there have consistently been positive relationships among farmers' education, years of experience, farm size, and income concerning intervention programs. This discovery is consistent with the results of Obadimu and Oluwalana (2018) that charcoal producers within their economically active years earned greater profits in the charcoal trade, and those involved in both production and marketing generated more revenue compared to those who solely focused on production. This finding is also in agreement with the data from the International Energy Agency (2022) and the World Energy Council (2020) regarding industrial charcoal production ventures and the energy sources utilised by rural households.

The study showed the variations in the monthly earnings and spending of the farming households in the research area. The findings revealed that a small proportion of respondents fell into the highest income bracket, with an even smaller proportion spending at that level. A very limited percentage of the respondents earned and spent at the uppermost income levels. These results align with the conclusions of Amusa *et al*. (2022), who discovered that the roles of men and women in agricultural decision-making and revenue are entirely dissimilar, and that farm costs can occasionally exceed earnings regardless of the size of the household. Akomolafe *et al.* (2018) also discovered that climate change and its impact on agricultural production in Nigeria significantly influence farmers' earnings. This result aligns with the conclusions of Mrindoko (2022) regarding the effect of charcoal production on the household income of smallholder farmers in Kenya, and corresponds with the work of Lai-Solarin, Adeoye, and Sennuga (2021) that suggests the implementation of innovative and straightforward technologies for charcoal production, along with sufficient financing, are means to reduce poverty levels among rural communities.

The research indicated that a significant relationship exists among the age of respondents, their educational attainment, household size, years of experience, monthly earnings, charcoal output, monthly spending, cooperative membership, and the socio-economic benefits of charcoal in Oyo State. However, there was no significant correlation noted between respondents' sex and interaction with forestry officials. These results align with the discoveries made by Balana and Oyeyemi (2022), who revealed that as farmers age, their capacity and physical strength for agriculture decrease, although their experience tends to increase. Balogun *et al.* (2021) also discovered that an increase in the size of a farming household correlates with greater expenditures. A notable relationship was found in the responses regarding charcoal production and the socio-economic impact of charcoal in the studied region, aligning with the observations made by Buhari (2022) that charcoal enterprises have emerged as a primary source of employment and profitable income for producers. A significant relationship was also present among the respondents' feedback on charcoal distribution and socioeconomic benefits, which is connected to the discoveries made by Chandio *et al.* (2020) that charcoal is currently being exported from Nigeria to various countries, generating substantial revenue. Similarly, a notable relationship was found among respondents' feedback regarding charcoal use and its socio-economic benefits, consistent with the conclusions of Dossou *et al*. (2020) that charcoal is currently utilised in multiple ways and is advantageous to both users and producers. A considerable distinction was identified in the respondents' feedback regarding the evaluation of charcoal's socioeconomic impact, which aligns with Dudel's (2020) findings that charcoal production has favourably impacted national revenue and has partially alleviated youth unemployment. Egboduku *et al*. (2021) also discovered that charcoal production has played a major role in enhancing the socioeconomic conditions of rural farming families who participated in it as their means of income.

Typically, the research indicated that most farming households experienced a positive effect from the production, distribution, and use of charcoal on their income and quality of life by enhancing their socioeconomic conditions. These results demonstrated that charcoal enterprises are quite profitable. The coefficients related to age, gender, years of experience, and charcoal output were positive and statistically significant. This suggests that both male-led and female-led farming households participated in either the production, distribution, or use of charcoal to enhance their socioeconomic conditions. These results support the conclusions of Etuk and Ayuk (2021), who discovered that all socioeconomic factors are directly related to the output of farmers, and Gona *et al.* (2020), who found that the number of years in the field can significantly influence the farmer's yield and earnings.

5. Conclusion

The research evaluated the socioeconomic benefits of charcoal production, distribution, and utilisation among farming families in Oyo State. The research findings concluded that charcoal production, distribution, and utilisation are very profitable and greatly impacted the socioeconomic status of the majority of the charcoal producers' farm families in the study region. Charcoal producers in their younger age with higher education and smaller household size, years of experience, monthly income and output that adopted modern techniques of production are of more benefits.

6. Recommendation

Drawing from the results of the research, it is recommended that programs that promote environmental awareness should be continuously developed to educate charcoal producers. Implementation of innovation and advancement of more efficient kilns for cooking should be enforced, which will enhance the effectiveness of charcoal

utilisation and hence, reduce the emission and improve cleanliness of kitchen settings.

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Authors' Contributions
Dr. Asamu contributed to conceptualization and methodology of the study, curated the data, and wrote the original draft as well as reviewed and edited the manuscript. Prof. Olawumi contributed to conceptualization and provided supervision. Prof. Awobajo contributed to conceptualization and provided supervision. Dr. Abiala contributed to conceptualization and methodology and reviewed and edited the manuscript. Dr. Osipitan contributed to methodology and reviewed and edited the manuscript. All authors have read and approved the final manuscript.

Data Availability Statement
The data supporting the findings of this study are available from Dr. Asamu, who served as the data curator, upon reasonable request. The data are not publicly available due to institutional guidelines.

Conflict of Interest Statement
The authors declare they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. No conflicts of interest exist.

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