

Assessment of charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State

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Abstract - This study examined the charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State. Using a mixed-methods approach involving structured questionnaires, key informant interviews, and field observations, data were collected from 150 respondents across the charcoal value chain. Results revealed that charcoal remains the dominant cooking fuel for 54% of households, with producers capturing only 38% of final value despite bearing the highest environmental costs. Although 70% of producers are aware of environmental impacts, only 15% practice conservation measures. The study identified poorly organized value chains, arbitrary price setting, and severe environmental degradation as key challenges. Producers derive 72% of household income from charcoal activities, highlighting heavy dependence on this livelihood source. Despite environmental concerns, 68% of respondents expressed willingness to switch to cleaner fuels if affordable and accessible. The findings demonstrate weak institutional regulation and governance gaps in the charcoal market. The study recommends formalizing the value chain, supporting producer cooperatives, enforcing forest conservation measures, and promoting clean energy transitions to balance socioeconomic benefits with environmental sustainability.

Keywords: charcoal marketing, environmental degradation, socioeconomic impact

INTRODUCTION

Charcoal remains a significant source of household energy in Maiduguri, especially in the context of prolonged insecurity and poverty that have limited access to alternative fuels such as LPG and electricity. Charcoal is a primary source of cooking energy in Maiduguri, especially among low-income households. As of 2024, over 70% of households in Maiduguri rely on firewood or charcoal for daily cooking due to limited access to LPG and erratic power supply (Chima, 2021).

The charcoal trade has economic significance in Borno State, providing livelihoods for hundreds of smallholder producers, transporters, and vendors. However, its unregulated nature contributes to widespread deforestation, inefficient production techniques, and unsustainable resource extraction (FAO, 2022). Despite this dual nature, little scholarly or policy attention has been paid to the market structure, limiting effective intervention.

Recent studies have highlighted the increasing reliance on traditional biomass for cooking in Sub-Saharan Africa, particularly in conflict-affected areas such as Northeast Nigeria (Ogundele et al., 2023a). According to the Food and Agriculture Organization (FAO, 2022), unsustainable charcoal production is a leading driver of deforestation in dryland forests. UNDP (2023a) emphasizes the urgent need for decentralized, renewable energy solutions in crisis-prone regions to reduce dependence on fuel wood.

Conflict-driven displacement, particularly from Boko Haram violence, has spurred heavy dependence on charcoal and firewood. HumAngle reports that IDPs and low-income households in Borno have significantly depleted surrounding bush areas to meet fuel needs, causing severe

deforestation in Maiduguri, Jere, Konduga, and Kaga (Umar, 2025). Daily Trust estimates nearly 600 firewood truckloads enter Maiduguri daily, highlighting the scale of unsustainable fuelwood consumption (Omirin, 2024).

Aliyu and Ibrahim (2024) highlighted that even in the face of government bans, deforestation in Borno remains severe, trees are still being felled because no viable alternatives have been offered to local communities. Despite regulatory bans, illegal tree-felling persists in Borno. Blueprint (Yusuf and Musa, 2024) noted that the practice is expanding, exacerbated by rising kerosene and gas prices.

Local youth-led enterprises such as Kariye Green Bio Energy are pioneering agrarian waste-based charcoal briquettes, using cassava, rice husks, coconut shells, and banana peels (Alibe, 2024). These eco-friendly briquettes are more efficient, reduce deforestation, provide livelihoods, providing a grassroots model for decentralized energy systems and empower youth (Alibe, 2024; Aliyu and Ibrahim, 2024; Umar, 2025).

While direct studies are limited, successful models in Niger and Benue showed that community-led woodlot and cooperative frameworks can stabilize incomes and support regrowth (Yusuf and Bakare 2022). Field accounts provided details of women and IDPs trained in charcoal briquette production by NGOs like SPeHDI. Participants reported improved income, social purpose, and cleaner fuel alternatives (Adamu and Kaletapwa, 2023).

Charcoal marketing in Maiduguri is marked by poorly organized value chains, arbitrary price setting, low value capture for rural producers, and severe environmental degradation. Without proper knowledge of the market structure,

regulatory interventions may fail to address the core issues or may worsen socio-economic vulnerabilities. This study explored the marketing structure of charcoal in Maiduguri and evaluated its socioeconomic contributions and environmental impacts to inform sustainable energy policies and promote responsible forest management.

The study was guided by the following hypotheses:

H₀1: The charcoal marketing structure in Maiduguri is characterized by poorly organized value chains where producers capture the smallest share of economic value despite bearing the highest environmental costs.

H₀2: There is a significant knowledge-practice gap among charcoal producers regarding environmental conservation, with high awareness but low implementation of sustainable practices.

H₀3: Households in Maiduguri demonstrate heavy dependence on charcoal for both energy needs and income generation, but express willingness to adopt cleaner alternatives if they are affordable and accessible.

H₀4: The charcoal market operates with weak institutional regulation and governance gaps, contributing to unsustainable resource extraction and environmental degradation.

METHODOLOGY

The study was conducted in Maiduguri Metropolitan Council (MMC) and surrounding local government areas including Jere and selected areas of Konduga Local Government Area. The study area was chosen due to its significance as a major charcoal consumption centre and its proximity to production areas affected by conflict and environmental degradation.

A mixed-methods research design was employed, combining quantitative and qualitative approaches to provide comprehensive insights into the charcoal marketing structure and its effects. This approach enabled data triangulation for robust analysis and validation.

Data collection involved three primary methods:

1. **Quantitative data collection:** Structured questionnaires were administered to producers, transporters, retailers, and consumers across the charcoal value chain. The questionnaires captured information on demographics, income sources, pricing mechanisms, market structure, environmental awareness, and energy preferences.

2. **Qualitative data collection:** Key informant interviews were conducted with community leaders, forestry officers, NGO representatives, and market association leaders to gather in-depth insights into market dynamics, policy gaps, and governance challenges.

3. **Field observation:** Direct observation was conducted at charcoal production areas, markets, storage facilities, and transportation routes to document operational practices, market conditions, and environmental impacts.

Stratified random sampling was employed to ensure representation across different actors in the charcoal value chain. The sample was stratified into four categories: producers, transporters, wholesalers/retailers, and consumers. A total sample size of 150 respondents was selected, distributed as follows: producers (40), transporters (30), wholesalers/retailers (35), and consumers (45).

Data analysis employed multiple techniques:

1. **Descriptive Statistics:** SPSS software was used to generate frequencies, percentages, means, and standard deviations for quantitative data.
2. **Value Chain Mapping:** Visual mapping of actors, processes, and value flows to understand market structure and relationships.
3. **SWOT Analysis:** Assessment of strengths, weaknesses, opportunities, and threats in the charcoal marketing system.
4. **Environmental Impact Scoring:** Proxy indicators were used to assess environmental degradation levels associated with charcoal production and trade.

Qualitative data from interviews and observations were analysed using thematic analysis to identify key patterns and themes related to market dynamics, governance gaps, and sustainability challenges.

RESULTS AND DISCUSSION

Charcoal value chain structure and value capture

- The charcoal value chain in Maiduguri consists of five main actors: producers, transporters, wholesalers, retailers, and consumers. The analysis revealed a linear value chain with limited integration and coordination among actors.

Table 1: Key actors and their roles in the charcoal value chain

Actor	Role	Average price (₦/100kg bag)
Producers	Cut and carbonize wood in rural areas of Borno/Yobe State	3,000
Transporters	Transport charcoal using trucks, motorcycles, donkey carts	4,000
Wholesalers	Store and distribute in bulk to retail vendors	5,600
Retailers	Sell small bags to final consumers at roadside and markets	7,600
Consumers	End users including households, restaurants, food vendors	-

Value capture analysis showed significant disparities across the chain. Producers, who have the highest environmental and labour costs, captured only 38% (₦3,000) of the final retail value (₦7,600). Transporters captured 22% of the added value,

wholesalers 15%, and retailers 25%. This distribution pattern confirms the first hypothesis (H_1) that producers capture the smallest economic value despite bearing the highest costs.

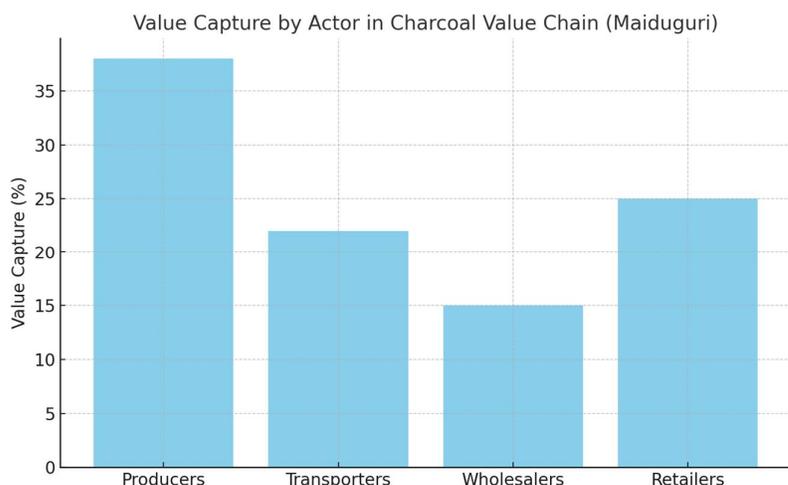


Figure 1: Value capture by actors in the charcoal value chain (Bar chart showing: Producers 38%, Transporters 22%, Wholesalers 15%, Retailers 25%)

Socioeconomic impact assessment

Household income dependency - The study revealed heavy dependence on charcoal-related activities for household income across all

actor categories. Producers derived the highest proportion of household income from charcoal activities at 72%, followed by transporters at 65%, and retailers at 58%.

Table 2: Household Income Share from Charcoal Activities

Actor category	Percentage of household income from charcoal (n=150)	Average Monthly Income (₦)
Producers	72%	90,000
Transporters	65%	104,000
Retailers	58%	96,000
Overall Average	65%	96,666

This finding supports hypothesis H_3 , demonstrating a significant household dependence on charcoal for income generation. The high

dependency rates reflect limited alternative livelihood opportunities in conflict-affected areas of Northeast Nigeria.

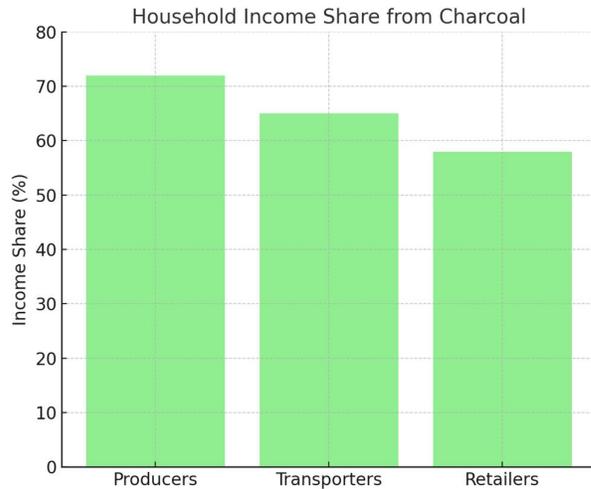


Figure 2: Share of household income derived from charcoal activities (Bar chart showing income percentages by actor category)

Employment and livelihood impacts -

Field observations and interviews revealed that the charcoal trade provides employment opportunities for various demographic groups, particularly youth, women, and displaced persons. Approximately 60% of producers were found to be young adults (18-35 years), while 35% of retailers were women engaged in small-scale trading activities.

Environmental impact and conservation practices

Environmental awareness vs practice gap

The study revealed a significant knowledge-practice gap regarding environmental conservation among charcoal producers, supporting hypothesis H₂. While 70% of producers demonstrated awareness of the environmental impacts of charcoal production, only 15% actually practiced conservation measures such as selective harvesting or tree planting.

Table 3: Environmental awareness and conservation practices among producers

Awareness/Practice Category	Percentage (n=40)
Aware of environmental impacts	70%
Practice selective harvesting	12%
Engage in tree planting	8%
Use improved carbonization techniques	18%
Participate in forest conservation programs	5%

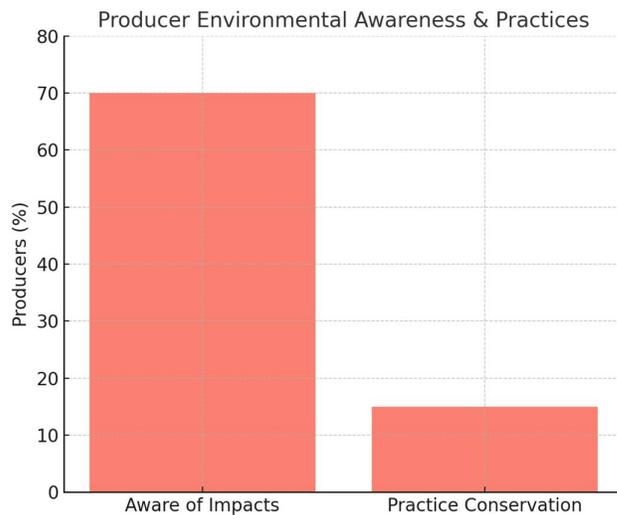


Figure 3: Environmental awareness and practices among producers (Bar chart comparing awareness (70%) vs actual practices (averaging 10.75%))

The knowledge-practice gap was attributed to several factors identified through key informant interviews: poverty constraints, lack of incentives for conservation, absence of alternative livelihoods, weak regulatory enforcement, and limited access to improved technologies.

Deforestation impacts - Field observations documented extensive tree cutting in production areas, with an estimated 600 truckloads of firewood entering Maiduguri daily (Omirin, 2024). Key informants reported visible forest degradation, reduced tree density, and increased

distances to access suitable wood resources. Producers reported traveling increasingly longer distances (average 15-25 km) to find adequate wood supplies, indicating progressive resource depletion.

Consumer energy use patterns and preferences primary cooking fuel usage - Consumer survey results showed charcoal as the dominant cooking fuel among households in Maiduguri, used by 54% of respondents. This was followed by firewood (28%), LPG (10%), and other fuels (8%).

Table 4: Primary Cooking Fuel Usage Among Consumers

Fuel Type	Percentage (n=45)	Main Reasons for Use
Charcoal	54%	Affordability, availability, reliability
Firewood	28%	Low cost, cultural preference
LPG	10%	Convenience, cleanliness
Others (kerosene, electricity)	8%	Availability, specific uses

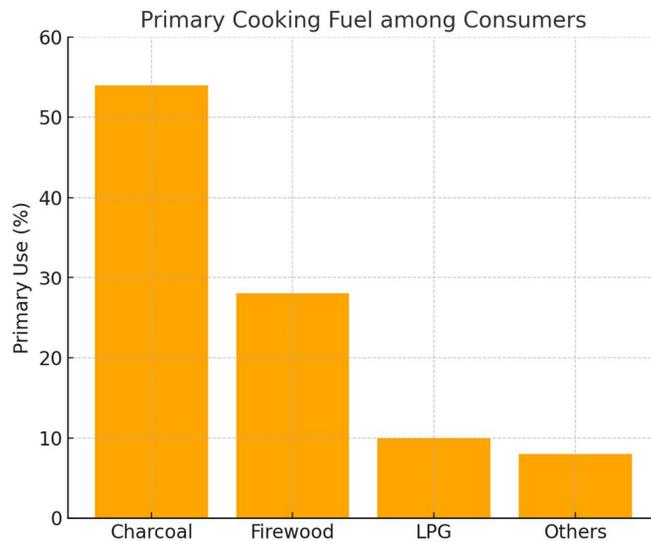


Figure 4: Primary cooking fuel among consumers in Maiduguri (Bar chart showing fuel distribution percentages)

Willingness to adopt alternative fuels - Despite heavy reliance on charcoal, 68% of consumers expressed willingness to switch to cleaner fuels if they were affordable and accessible. This finding partially supports hypothesis H₃ and indicates significant potential for clean energy transitions. The main barriers to adoption identified were high initial costs (72%), limited availability (58%), and lack of awareness about alternatives (45%).

Market structure and price-setting mechanisms, price formation and market power - The study revealed arbitrary price-setting mechanisms with limited transparency and high information asymmetry. Prices were primarily determined by wholesalers and retailers, with producers having minimal influence on pricing decisions. Market power was concentrated among transporters and wholesalers who controlled access to urban markets.

Table 5: Price variations and seasonality in charcoal markets

Season	Producer Price (₦/100kg)	Retail Price (₦/100kg)	Price Margin (₦)
Dry Season (Nov-Mar)	2,400-13,000	6,400-7,600	4,000-4,600
Rainy Season (Apr-Oct)	3,000-3,600	7,600-9,000	4,600-5,400
Average	3,000	7,600	4,600

Price variations were influenced by seasonal factors, transportation costs, and market demand fluctuations. During the rainy season, transportation difficulties and reduced production led to higher prices, benefiting intermediaries more than producers.

**Policy and governance analysis
regulatory framework assessment**

The study confirmed hypothesis H₄ regarding weak institutional regulation and governance gaps. Key findings included:

1. **Informal Operations:** 85% of producers operated without formal licenses or

permits, indicating widespread informality in the sector.

2. **Multiple Taxation:** Transporters faced numerous informal levies at checkpoints, adding to operational costs and consumer prices.
3. **Weak Enforcement:** Environmental regulations existed but were poorly enforced due to security constraints and limited institutional capacity.
4. **Absence of Support Systems:** Lack of cooperatives, credit facilities, and technical support for sustainable practices.

Table 6: Governance challenges in charcoal marketing

Challenge Category	Specific Issues	Percentage of respondents affected
Licensing and Regulation	Lack of formal permits	85%
Taxation	Multiple informal levies	78%
Market Access	Limited transportation options	65%
Credit Access	No formal credit facilities	92%
Technical Support	Limited extension services	88%

SWOT analysis of charcoal marketing in Maiduguri

Based on the findings, a SWOT analysis was conducted to assess the charcoal marketing system:

Strengths:

1. Provides significant employment and income opportunities
2. Well-established market networks and distribution channels
3. High consumer demand and acceptance
4. Indigenous knowledge of production techniques

Weaknesses:

1. Poorly organized value chains with unfair value distribution
2. Environmental unsustainability and resource depletion
3. Weak institutional regulation and governance
4. Limited access to improved technologies and credit

Opportunities:

1. Growing market demand due to energy poverty
2. Potential for sustainable production methods and alternatives
3. Government interest in renewable energy and forest conservation

4. Youth and women engagement in value-added activities

Threats:

1. Continued environmental degradation and deforestation
2. Climate change impacts on resource availability
3. Security challenges affecting production and transportation
4. Competition from improved alternatives (LPG, renewable energy)

CONCLUSION AND RECOMMENDATIONS

This study examined the charcoal marketing structure and its socioeconomic and environmental effects in Maiduguri, Borno State. The findings confirmed all four research hypotheses, revealing a complex system that provides crucial livelihoods but operates unsustainably with significant environmental costs.

The charcoal value chain in Maiduguri is characterized by poorly organized structures where producers, despite bearing the highest environmental and labour costs, capture only 38% of the final economic value. This inequitable distribution reflects power imbalances and weak market organization that disadvantage rural producers while benefiting intermediaries.

The study identified a significant knowledge-practice gap in environmental conservation, with 70% of producers aware of environmental impacts but only 15% implementing sustainable practices. This gap stems from poverty constraints, lack of incentives, weak regulatory enforcement, and limited access to alternative technologies and livelihoods.

Heavy household dependence on charcoal-related activities was evident, with producers deriving 72% of their income from charcoal trade. This dependency reflects limited livelihood alternatives in conflict-affected Northeast Nigeria. However, the finding that 68% of consumers express willingness to adopt cleaner alternatives if affordable and accessible indicates significant potential for sustainable energy transitions.

The study confirmed weak institutional regulation and governance gaps, with 85% of producers operating informally, multiple informal taxation, and minimal enforcement of environmental policies. These governance deficits perpetuate unsustainable practices and limit opportunities for sector transformation. Based on the findings, the following recommendations are proposed:

Policy and regulatory reforms

1. Formalize the Charcoal Value Chain:

The Federal Ministry of Environment (FME), in collaboration with the Federal Ministry of Agriculture and Food Security (FMAFS) and State Ministries of Environment, should develop and enforce policies to formalize charcoal production and trade, including simplified licensing procedures, fair taxation, and legal recognition of producer associations.

2. Strengthen environmental governance:

The National Environmental Standards and Regulations Enforcement Agency (NESREA) and State Forestry Departments should enforce forest conservation laws, establish monitoring systems, and apply penalties for unsustainable practices. Local Government Councils and NGOs should support alternative livelihood programs.

3. Integrate energy and climate policies:

The Energy Commission of Nigeria (ECN), in partnership with the Federal Ministry of Power and National Council on Climate Change (NCCC), should incorporate sustainable charcoal production into national energy and climate action plans.

Market development and value chain enhancement

1. Support Producer Cooperatives:

The State Ministries of Commerce and Cooperative Societies, NGOs, and Development Partners (e.g., UNDP, FAO) should facilitate the formation and registration of producer cooperatives to improve bargaining power and promote collective action.

2. Improve Market Information Systems:

The Federal Ministry of Trade and Investment (FMTI) and National Bureau of Statistics (NBS) should develop and maintain market information platforms and transparent pricing mechanisms, while charcoal associations help disseminate data to producers and traders.

3. Develop Value-Added Activities:

The Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and Bank of Industry (BOI) should support value addition (e.g., briquette manufacturing, packaging) through training, funding, and technology transfer.

Environmental Sustainability

1. Promote sustainable production techniques:

The State Forestry Departments, Nigerian Forestry Research Institute (FRIN), and Extension Services should provide training on improved carbonization, selective harvesting, and reforestation.

2. Establish forest management programs:

The State Ministries of Environment, in collaboration with Community-Based Organizations (CBOs) and traditional institutions, should implement community-based forest management, woodlot development, and reforestation initiatives.

3. Develop alternative energy sources:

The Federal Ministry of Science, Technology and Innovation (FMSTI) and Renewable Energy Research Centres should promote clean cookstoves, biogas, and solar energy adoption, supported by private sector investors.

Socioeconomic support

1. Provide financial services:

The Central Bank of Nigeria (CBN), through microfinance institutions and development banks, should design micro-credit schemes tailored for charcoal producers, transporters, and marketers.

2. Enhance capacity building:

The National Directorate of Employment (NDE) and Non-Governmental Organizations (NGOs) should organize training programs on sustainable production, entrepreneurship, and alternative livelihoods.

3. Support vulnerable groups:

The Federal Ministry of Women Affairs, National Youth Service Corps (NYSC) Skills Unit, and Humanitarian Agencies should design programs targeting women, youth, and displaced persons engaged in charcoal trade.

Research and development

1. Promote technology innovation:

The Forestry Research Institute of Nigeria (FRIN), universities, and polytechnics should lead R&D on efficient charcoal production technologies and alternative biomass fuels, supported by TETFund and international partners.

2. Conduct regular monitoring:

The National Bureau of Statistics (NBS), NESREA, and academic institutions should establish

monitoring frameworks to assess environmental impacts, market trends, and policy effectiveness.

3. Document best practices:

The Federal Ministry of Environment, in collaboration with research institutions, NGOs, and media organizations, should identify and document successful community-based models for replication and scaling up.

Multi-Stakeholder collaboration

1. **Strengthen institutional coordination:** Enhance coordination among government agencies, NGOs, private sector, and community organizations involved in energy, environment, and development sectors.
2. **Promote public-private partnerships:** Encourage partnerships between government, private sector, and development partners to mobilize resources and expertise for sector transformation.
3. **Engage communities:** Ensure meaningful participation of local communities, particularly producers and consumers, in policy development and program implementation.

These recommendations should be implemented through a phased approach, starting with immediate interventions to address urgent needs while building foundations for longer-term sustainable transformation of the charcoal marketing system in Maiduguri and similar contexts.

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