COMMUNITY PERCEPTION AND PARTICIPATION IN THE PALM KERNEL SHELL (PKS) VALUE CHAIN IN CROSS RIVER STATE, NIGERIA

Inyang Nelson INYANG[1], Itojong Anthony AYAMBA[2], Timothy Okey OGAR[3], Martha Desmond EWA[4]

[1]Department of Geography and Environmental Science, Faculty of Environmental Sciences University of Calabar, Calabar- Nigeria. inyangnelson@unical.edu.ng
[2]Department of Public Administration, Faculty of Administration and Management Sciences, University of Calabar, Calabar- Nigeria. ayambaitojong@unical.edu.ng
[3]Department of Geography and Environmental Science, Faculty of Environmental Sciences University of Calabar, Calabar- Nigeria. timexo2@yahoo.com
[4]Department of Geography and Environmental Science, Faculty of Environmental Sciences University of Calabar, Calabar- Nigeria. marthaewa@gmail.com

DOI: https://doi.org/10.5281/zenodo.18050484

Abstract
The Palm Kernel Shell (PKS) value chain is an emerging driver of sustainable bioenergy and rural livelihoods in Nigeria. Once regarded as agricultural waste, PKS now serves as a biomass fuel for industries. This study investigates community perceptions, participation, and governance challenges in the PKS trade across four communities in Cross River State. Using a mixed-methods approach, data were collected from 200 respondents through structured questionnaires, key informant interviews, and field observations. Results show 46% involvement in PKS activities, with benefits to food security, education, and healthcare. However, informality, limited cooperative membership (28%), and poor access to finance (72%) persist. Also, environmental concerns affect nearly half of respondents, while gender exclusion and weak governance undermine equity and sustainability. The study recommends the need for improved governance, cooperative support, environmental safeguards, and inclusion of women and youth to realize the PKS sector's full potential as a sustainable, inclusive bioenergy economy.

Keywords: Palm Kernel Shell, community perception, sustainable livelihoods, political economy, Cross River State, inclusive policy.

1. INTRODUCTION

The palm kernel shell (PKS) is a by-product of palm oil processing that was traditionally considered agricultural waste in Nigeria and other parts of West Africa. However, with the rising demand for sustainable energy solutions, PKS has gained renewed attention as a biomass energy resource due to its high calorific value (16–18 MJ/kg), low ash content, and economic viability for industrial and domestic use (Demirbas, 2004; Gyamfi et al., 2023). In Nigeria, where energy access and environmental degradation remain critical development challenges, PKS offers a dual opportunity to address energy poverty and promote inclusive rural economic development (UNDP, 2023). In recent years, the Mfamosing Cement Plant in Cross River State has adopted PKS as an alternative fuel in its production kilns, replacing fossil fuels with locally sourced biomass. This shift aligns with the global trend toward circular economy models, where agricultural residues are repurposed to reduce carbon emissions and enhance community resilience (IEA Bioenergy, 2022). Consequently, PKS has transitioned from waste to wealth, spawning an informal but rapidly expanding value chain across palm-rich communities such as Akansoko in Akpabuyo Local Government Area (4.8775° N, 8.4672° E), Ikperi Ikang in Bakassi LGA (4.6212° N, 8.5528° E), Ukomita in Akamkpa LGA (5.1547° N, 8.5635° E), and Ukwa Eburutu in Odukpani LGA (5.1710° N, 8.3931° E), all strategically situated within the coastal and inland ecological belts of Cross River State.

This emerging PKS economy is characterized by a diverse array of actors including collectors, transporters, middlemen, and industrial buyers. For rural populations, particularly those excluded from formal employment systems, PKS-related activities offer an accessible source of livelihood with relatively low entry barriers (Musa et al., 2022). Income generated through PKS has been reported to contribute to food security, healthcare access, children's education, and informal savings, particularly among youth and women engaged in small-scale processing and selling (Ekpo & Essien, 2018).

Despite these benefits, the political economy of biomass trade in Nigeria raises important concerns regarding governance, equity, and environmental sustainability. Currently the global disappearance and declined in flora species presents the entire world with one of its greatest conservation challenges, Inyang, I. N., Digha, O. N & Ikono, E. C. (2021). The sector remains largely informal, poorly regulated, and vulnerable to elite capture, leaving communities at risk of exploitation, unsustainable harvesting practices, and environmental degradation (World Bank, 2022). Moreover, the involvement of industrial actors without corresponding community benefit-sharing mechanisms has led to growing tensions and inequities in resource access and pricing (Ogunbode & Olowu, 2020).

Additionally, gender and youth inclusion remains limited in formal decision-making structures related to PKS trade. Many women and young people face structural barriers, including lack of capital, exclusion from cooperatives, and limited access to markets or training, which perpetuate their marginalization even in resource-rich rural settings (UN Women, 2021). The absence of localized policies or community-led regulations further undermines sustainable use and social cohesion.

This study therefore seeks to provide an empirical, community-based assessment of the PKS value chain in Cross River State. By focusing on four active communities, Akansoko, Ikperi Ikang, Ukomita, and Ukwa Eburutu, the research aims to explore local perceptions, participation levels, and policy needs around the PKS economy. It also interrogates how environmental risks and local governance mechanisms shape community experiences, while identifying strategies for creating an inclusive, equitable, and sustainable PKS-based economy. Findings from this research contribute to the broader discourse on biomass governance, circular economies, and inclusive energy transitions in Sub-Saharan Africa.

2. STATEMENT OF THE RESEARCH PROBLEM

Despite the growing recognition of Palm Kernel Shell (PKS) as a valuable biomass resource and income source for rural communities in Cross River State, its rapid commercialization has outpaced institutional regulation and inclusive governance. The absence of clear policies, cooperative structures, and environmental safeguards has resulted in inequitable benefit distribution, gender and youth marginalization, and increasing ecological stress such as deforestation and air pollution. Consequently, the PKS sector, though economically promising, risks replicating the same governance failures observed in Nigeria's broader extractive industries, where elite capture, informality, and weak environmental oversight undermine sustainability and community welfare.

2.1 Aim of the Study

To assess community perceptions, participation patterns, and governance challenges in the Palm Kernel Shell (PKS) value chain within selected rural communities of Cross River State, with a view to promoting inclusive, sustainable, and environmentally responsible utilization of PKS resources.

2.2 Objectives of the Study

1. To examine the level and forms of community participation in the Palm Kernel Shell (PKS) value chain across selected communities in Cross River State.
2. To identify the key governance, environmental, and socio-economic challenges affecting equitable participation and sustainability within the PKS trade.

3. LITERATURE REVIEW

This study is anchored in the political economy of natural resources and community-based resource governance theory, which emphasize how power relations, institutional arrangements, and informality shape access to resources and benefit distribution. Within this framework, Palm Kernel Shells (PKS) are understood not merely as biomass residues but as socio-economic resources whose governance determines livelihood outcomes, equity, and sustainability. By situating PKS within the broader discourse on circular economy and informal value chains, the study provides a theoretically grounded explanation of how community participation and weak regulatory oversight influence the structure and performance of the PKS value chain in Cross River State. While the study draws on relevant and contemporary literature, deeper engagement with comparative African biomass value-chain studies was constrained by manuscript length rather than conceptual limitation.

Bioenergy is increasingly recognized as a viable component of sustainable development and climate adaptation strategies across Africa. The continent faces a dual challenge of high energy poverty and abundant biomass residues positioning bioenergy as a strategic opportunity to enhance energy access while mitigating environmental degradation (IEA, 2022; UNDP, 2023). In particular, palm kernel shell (PKS), a by-product of palm oil production, has emerged as a low-cost, low-carbon fuel alternative suitable for both domestic and industrial energy use.

In West Africa, bioenergy transitions are gaining momentum amid the search for renewable energy solutions. Countries like Nigeria, Ghana, and Côte d'Ivoire have significant biomass reserves from agricultural waste including cocoa husks, maize stalks, and PKS (IRENA, 2021). However, as Gyamfi et al. (2023) emphasize, regional policies on bioenergy are often reactive, poorly coordinated, and disconnected from community realities, leading to missed opportunities for rural development and environmental sustainability.

In Nigeria, although the Renewable Energy Master Plan (REMP) recognizes biomass as a strategic energy source, implementation has been hampered by weak institutional frameworks, lack of data, and inadequate funding (NESP, 2020). As a result, bioenergy development remains driven largely by informal actors or private industries, such as cement and agro-processing companies, that utilize PKS and other residues without clear regulatory guidelines or benefit-sharing mechanisms with host communities (Akinbami et al., 2019).

The circular economy framework, promoted by international development agencies, encourages the repurposing of waste streams like PKS into productive economic assets. However, without policy coherence, inclusive participation, and environmental safeguards, the risk of "green extraction" remains where sustainability is proclaimed but inequities persist (World Bank, 2022).

3.1 Political Economy of Resource Extraction

The political economy of natural resources in Nigeria has long been shaped by extraction without adequate redistribution. From oil to forestry and now biomass, the pattern is often characterized by centralized control, elite benefit capture, and community marginalization (Watts, 2008; Obi, 2010). While PKS is not

as politically contentious as oil, its growing commercial relevance raises similar concerns around governance, equity, and sustainability.

Ogunbode and Olowu (2020) argue that resource governance in Nigeria often excludes local voices, particularly in rural and indigenous communities. In the case of PKS, its informal nature has resulted in unregulated harvesting, opaque pricing structures, and conflicts over access between traditional landowners, youth groups, and industrial buyers. This mirrors wider patterns in the country's extractive history, where the absence of community-driven institutions leads to the erosion of traditional livelihoods and environmental degradation.

Furthermore, the lack of recognition of customary rights and the commodification of biomass resources like PKS without institutional frameworks for revenue sharing or environmental accountability can lead to growing distrust, social tensions, and resistance from affected communities (Assembe-Mvondo et al., 2021). These dynamics call for a rethinking of how local governance, policy design, and resource access are structured in Nigeria's emerging green economy.

3.2 Informal Markets and Livelihoods

Informality is a defining feature of the PKS value chain and many other biomass-based economic activities in Sub-Saharan Africa. While the informal sector often provides critical employment opportunities, especially for women and youth, it also exposes participants to precarious income flows, lack of legal protections, and environmental risks (Chen, 2012; Ekpo & Essien, 2018).

In the case of PKS, collection, transportation, and small-scale trade are mostly unregistered activities with little or no access to formal financing, cooperatives, or technical support. This reality makes PKS actors vulnerable to price volatility, exploitative middlemen, and labour insecurity. A study by Musa et al. (2022) highlights that while informal biomass activities contribute to household resilience, they often reinforce gender and income inequalities, especially where women are excluded from higher-value nodes of the chain, such as bulk sales or industrial supply contracts. Moreover, the environmental costs of informal biomass exploitation are frequently borne by local ecosystems and poor households. Unregulated harvesting, burning for fuel, and improper waste disposal can result in deforestation, soil degradation, and air pollution threatening long-term community well-being (Adelekan & Jerome, 2019). Without formal recognition or integration into broader energy and development policies, these informal livelihoods may not be sustainable, despite their short-term economic importance.

Thus, addressing the informality of the PKS economy requires targeted interventions that promote inclusive formalization, provide access to financial services, and strengthen community-based governance frameworks. Such strategies can help shift the sector from a survivalist economy to a more sustainable and equitable component of Nigeria's rural development agenda.

4. METHODOLOGY

This research adopted a mixed-methods approach, integrating both quantitative and qualitative techniques to triangulate data and enhance the validity of findings (Bryman, 2016). The design allowed for a deeper understanding of not just *what* is happening in the PKS value chain, but *why* and *how* certain patterns emerge, particularly around community participation, environmental impact, and policy gaps. Combining both quantitative surveys and qualitative interviews enabled a comprehensive exploration of the formal and informal structures shaping the PKS system across the study areas.

The household survey was designed to capture community-level perceptions, participation patterns, income dependence, and gender roles within the PKS value chain. These dimensions are critical for understanding governance gaps and sustainability challenges that cannot be adequately assessed through observation alone. Community perceptions provide insight into informal rules, power relations, and livelihood dependence, which are central to evaluating the socio-economic and environmental implications of PKS exploitation.

Although the study does not test formal statistical hypotheses, it is guided by the following propositions:
(i) Community participation in the PKS value chain is shaped largely by informal governance structures;
(ii) PKS extraction contributes significantly to rural livelihoods but operates with limited regulatory oversight; and
(iii) Weak institutional frameworks constrain the sustainability and equity of PKS utilization.

4.1 Sampling Strategy

A total of 200 respondents were surveyed across the four communities. The choice of 200 respondents was informed by both statistical and practical considerations. Statistically, using a 95% confidence level ((z = 1.96)) and a conservative variance assumption ((p = 0.5)), this sample yields an estimated ±7% margin of error, which provides acceptable precision for community-level analysis. Practically, this size allowed for detailed community comparisons while keeping the fieldwork manageable within the four-week study period.

Each of the four selected communities contributed 50 respondents, ensuring equal representation for comparison and reducing bias from population size differences. These communities were chosen based on the prominence of PKS-related activities and the presence of both direct and indirect participants in the value chain. Within each community, a stratified random sampling technique was used to ensure representation across gender, age, and occupation categories. Stratification was designed to capture:

i. Gender balance (at least 40% women per site)
ii. Age representation, focusing on youth (18–35 years) and older adults
iii. Participation diversity, involving actors directly and indirectly linked to PKS (e.g., collectors, sellers, bystanders, and farmers)

This design minimized selection bias and allowed for generalization within the community context (Etikan & Bala, 2017).

4.2 Rationale and Process of Selection

The sampling process began with community entry and mapping, undertaken in collaboration with community leaders. Before selecting households, researchers conducted brief mapping to estimate household numbers, identify PKS activity points (mills, aggregation centers, local markets), and delineate residential zones. Where household lists were unavailable, a door count was used to approximate the sampling frame.

At each community, enumerators used a systematic random approach combined with gender and age quotas. From the household listing or estimates, a random starting point was chosen, and every *kth* household was visited to achieve 50 interviews per community. Within each selected household, the enumerator ensured the inclusion of respondents fitting the next needed quota category (for example, if

women were underrepresented, preference was given to an adult female respondent in the next selected household). When a selected household had no eligible or willing respondent, a substitution rule was applied, moving to the next household along the same line of selection.

The study specifically targeted local farmers and PKS value chain actors, as these groups form the socioeconomic base of the bioresource economy in the study area. Farmers were included because PKS is a byproduct of their oil palm production, while PKS collectors, transporters, and sellers represent the operational heart of the emerging value chain. These groups were identified through household screening questions (e.g., *"Are you or any household member involved in PKS collection, transport, selling, or processing?"*). When respondents answered "yes," they were automatically qualified as PKS actors and interviewed accordingly.

To balance representation, enumerators tracked gender participation throughout the fieldwork, ensuring that women constituted not less than 40% of respondents in each community. Women were often accessed in market clusters, cooperatives, and households engaged in small-scale trading or processing, while men were mostly identified in the transport, collection, and aggregation segments of the PKS chain. The youth category (18–35 years) was also deliberately targeted, recognizing their dominant role in manual labor and transport-related aspects of the trade.

4.3 Instrument Design

The survey instrument consisted of a structured questionnaire containing 30 questions divided into five major sections:

1. Demographic and socioeconomic profile
2. Participation in the PKS value chain
3. Livelihood impacts
4. Environmental and social effects
5. Policy, equity, and future expectations

Questions were a combination of closed-ended (Likert scales and multiple-choice) and open-ended types, allowing respondents to express personal experiences and local perspectives not captured by pre-coded options. The instrument was pretested and refined for clarity, cultural relevance, and simplicity.

4.4 Data Collection Methods

Data collection lasted for four weeks (June–July 2025) and employed multiple complementary methods to ensure data triangulation and validity.

a. Household Surveys

Enumerator-administered questionnaires were conducted in the local languages, Efik, Ejagham, and English, to ensure comprehension and cultural sensitivity. Enumerators were trained for three days on the survey protocol, ethical procedures, and language consistency. Prior to each interview, respondents provided verbal consent after the study purpose and confidentiality measures were explained. Each interview lasted approximately 25–30 minutes.

b. Key Informant Interviews (KIIs)

To supplement survey data, 12 Key Informant Interviews were conducted with individuals who hold relevant knowledge or decision-making influence. They included:

1. Community leaders (traditional chiefs, youth and women leaders)
2. PKS cooperative heads
3. Palm mill operators
4. Local government officials

These interviews focused on issues such as policy gaps, resource conflicts, environmental concerns, and inclusive governance in the PKS trade. KIIs were purposively selected to provide policy and institutional insights that complemented the household-level perceptions.

c. Direct Observation

Researchers carried out direct field observations at PKS harvesting, processing, and aggregation sites to validate and contextualize survey responses. Field notes were taken on observable conditions such as land use changes, gendered labor patterns, and environmental degradation (e.g., deforestation and burning practices). This helped align the quantitative data with lived realities on the ground.

4.5 Ethical and Field Considerations

Ethical clearance for the study was granted by the Cross River State Ministry of Environment and Sustainable Development. Community entry protocols were observed, with prior notification and endorsement from local leaders. All participation was voluntary, and respondents were assured of anonymity and confidentiality. Enumerators were trained to handle sensitive topics, such as land conflicts, economic hardship, and intra-community disputes, with empathy and neutrality. Data were stored securely and used solely for research purposes.

5. ANALYSIS

Quantitative Analysis

Survey data were entered and cleaned using Microsoft Excel and analyzed with SPSS (Version 27). Descriptive statistics were applied, including:

1. Frequency distributions
2. Means and medians
3. Cross-tabulations (e.g., gender vs. participation, income vs. financial access)

These analyses allowed for the identification of trends and comparisons between communities. Because each community contributed equally (50 respondents), no complex weighting was required during aggregation.

Qualitative Analysis

Open-ended survey responses and KIIs were coded and analyzed thematically using **NVivo software**. Thematic analysis followed Braun and Clarke's (2006) six-step framework:

1. Familiarization with data

2. Generation of initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the report

Emergent themes included youth marginalization, cooperative access, price manipulation, resource conflict, and sustainability concerns. The integration of quantitative and qualitative data strengthened both internal validity and contextual interpretation, offering a clearer understanding of the PKS value chain's socioeconomic and environmental dimensions.

6. RESULTS

Demographic Profile of Respondents

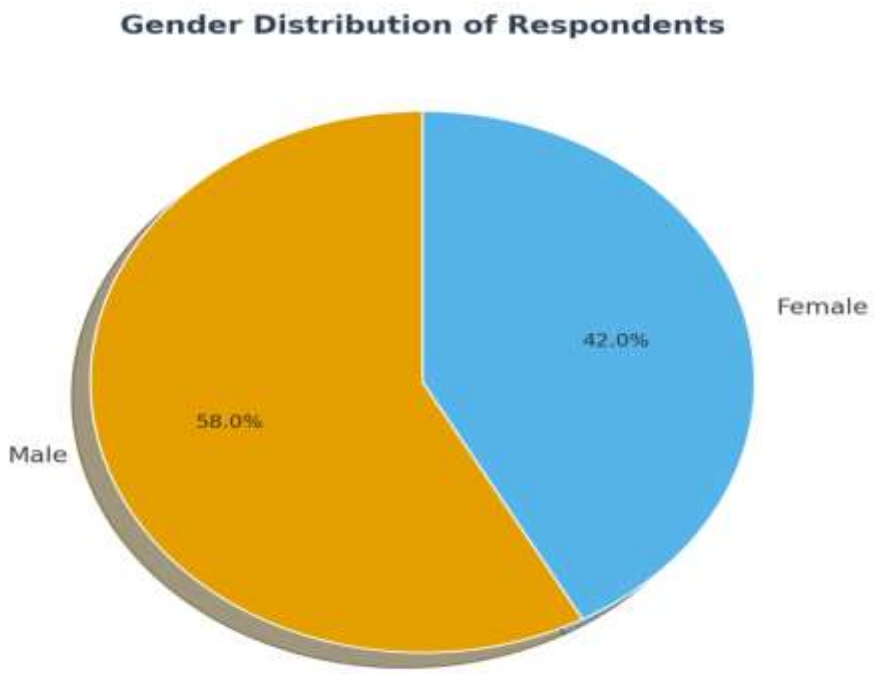
Out of the 200 respondents surveyed across the four communities, the demographic distribution revealed a youthful and moderately educated population with notable gender inclusion.

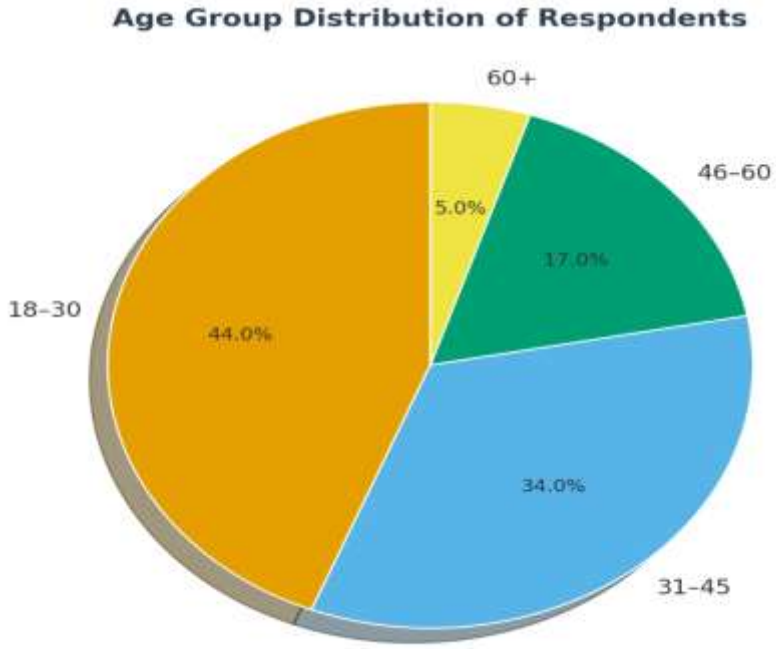
Table 1: Demographic Characteristics of Respondents

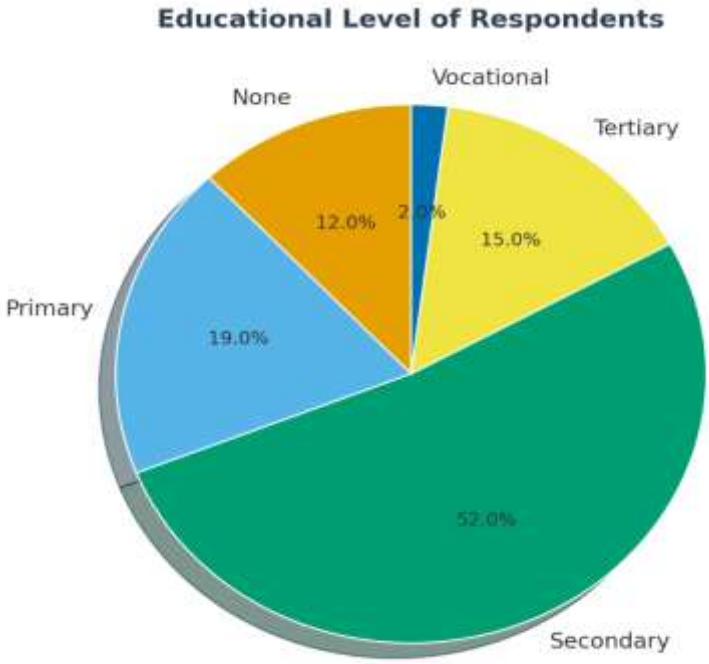
Variable	Frequency (%)
Gender	
Male	116 (58%)
Female	84 (42%)
Age Group	
18–30	88 (44%)
31–45	68 (34%)
46–60	34 (17%)
60+	10 (5%)
Educational Level	
None	24 (12%)
Primary	38 (19%)
Secondary	104 (52%)
Tertiary	30 (15%)
Vocational/Informal Training	4 (2%)
Primary Occupation	
Farming	60 (30%)
PKS-related Work	92 (46%)
Trading	26 (13%)
Civil Service	14 (7%)
Others	8 (4%)

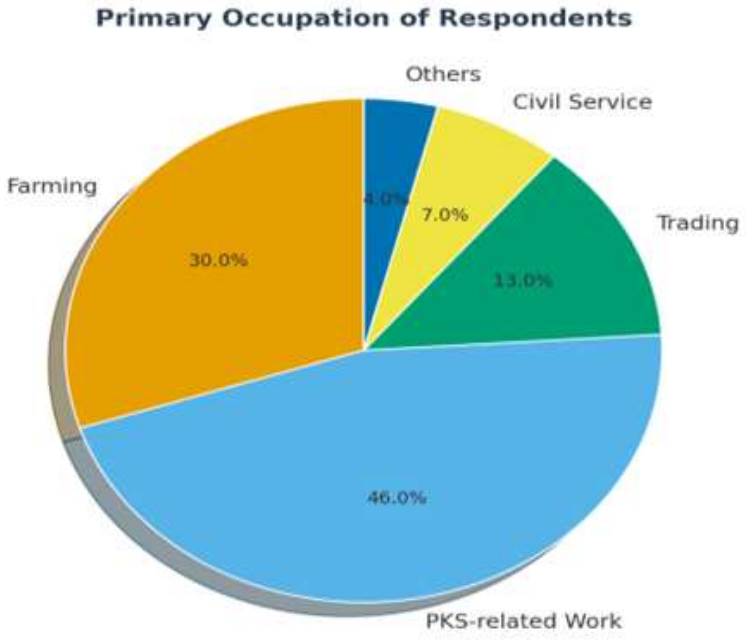
The dominance of the 18–45 age group (78%) indicates a youthful and economically active population, adaptable to green economy transitions. The high proportion (46%) of respondents involved in PKS-related work highlights the sector's centrality in local livelihoods. These findings suggest that livelihood

dependence on PKS is not only an economic phenomenon but also a reflection of governance vacuum, where informal arrangements substitute for formal regulatory mechanisms. This aligns with political economy perspectives that associate informality with uneven benefit distribution and sustainability risks.









7. DISCUSSION

This study confirms that the PKS value chain serves as an emerging economic engine in several rural communities of Cross River State. For many youth and low-income households, it offers a rare entry point into market participation. The sector provides modest but crucial income that supports food security, education, and health. However, the results also reveal that this economic activity remains highly informal, poorly regulated, and environmentally risky. As found in similar biomass economies in Ghana and Uganda (IRENA, 2021), informal bioenergy chains can unintentionally exacerbate inequality and degrade natural resources when community voices are excluded from governance. The limited participation of women and youth, coupled with the absence of formal rules or oversight, is a critical red flag for long-term sustainability. Echoing Ekpo & Essien (2018), unregulated biomass extraction not only marginalizes vulnerable groups but also increases the risk of conflict and ecological collapse. Therefore, without deliberate policy design, capacity building, and environmental safeguards, the PKS economy may repeat Nigeria's historical patterns of resource exploitation without inclusive development (Obi, 2010; World Bank, 2022).

8. CONCLUSION

The palm kernel shell (PKS) value chain in Cross River State exemplifies the paradox of resource-driven rural development in Nigeria where opportunities for income and energy innovation exist, but governance, equity, and environmental foundations remain weak. While many community members benefit economically from PKS, the value chain's informality, gender disparities, environmental degradation, and governance gaps threaten its viability. For PKS to evolve into a model of inclusive green growth, it must transition from an extractive to a regulated and community-driven enterprise.

From a policy perspective, the findings highlight the need for integrating community actors into formal biomass governance frameworks. Formal recognition of PKS as a bio-resource, coupled with community-based monitoring and licensing, could enhance equity, improve revenue accountability, and reduce environmental risks. Practically, the study demonstrates that sustainable PKS utilization depends not only

on market demand but on governance reforms that bridge the gap between informal practices and national bioenergy policy objectives.

8.1 Limitations of the Study:

i. The study focused on a limited number of communities, which may not represent all PKS value chains in Cross River State.
ii. Data collection relied mostly on self-reported survey responses, which can introduce bias.
iii. The cross-sectional design captures a single point in time, limiting insights into long-term trends.
iv. Limited in-depth ecological or environmental measurements related to PKS extraction impacts.
v. Formal statistical analysis was basic, restricting deeper causal understanding.

8.2 Areas for Future Research:

i. Expand studies to cover more communities and regions for broader representation.
ii. Conduct longitudinal research to track changes over time in PKS participation and environmental effects.
iii. Include detailed ecological assessments of PKS harvesting impacts on local ecosystems.
iv. Use advanced statistical or modeling methods to explore causal relationships in the value chain.
v. Investigate gender and youth inclusion barriers with focused qualitative approaches.
vi. Explore policy frameworks and community-based governance models for sustainable PKS management.

9. RECOMMENDATIONS

i. Community-Based PKS Policies: Establish and enforce local PKS management rules covering licensing, fair pricing, and sustainability to reduce conflicts and exploitation.

ii. Strengthen Cooperatives and Finance Access: Support cooperatives and provide low-interest loans to enhance savings, investment, and collective bargaining power among PKS actors.

iii. Gender and Youth Inclusion: Create empowerment programs for women and youth through training, tools, and flexible work opportunities to promote equal participation.

iv. Environmental Safeguards: Enforce restrictions on tree felling and burning, and promote community forest co-management to protect ecosystems.

v. Conflict Resolution Mechanisms: Empower traditional rulers and NGOs to mediate disputes and monitor fair access to PKS resources.

vi. Data and Sector Regulation: Institutionalize data collection on PKS production, pricing, and impacts to guide effective planning and sustainable regulation.

AUTHOR DECLARATIONS

Author Contributions: Conceptualization, I.N.I. and I.A.A.; Methodology, I.A.A. and T.O.O.; Software, I.A.A. and M.D.E.; Validation, I.N.I. and T.O.O.; Formal Analysis, I.A.A. and I.N.I.; Investigation, I.A.A., I.N.I., and T.O.O.; Resources, I.N.I.; Data Curation, I.N.I. and I.A.A., Writing, I.N.I.; Original

Draft Preparation, I.N.I. and I.A.A..; Writing, Review and Editing, I.N.I. and I.A.A.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical approval was obtained from the Akamkpa Local Government Council prior to community engagement.

Informed Consent Statement: Verbal informed consent was obtained from all participants involved in the study.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Adelekan, I. O., & Jerome, A. T. (2019). *Sustainable Biomass Energy Development in Nigeria: Constraints and Options*. Renewable Energy, 133, 1103–1115.

Aghalino, S. O. (2021). *Agricultural Decline and Nigeria's Oil-Driven Economy*. African Economic History Review.

Akinbami, J. F., Ilori, M. O., Oyebisi, T. O., & Adeoti, O. (2019). *Dissemination of Renewable Energy Technologies in Nigeria: Challenges and Prospects*. International Journal of Energy Sector Management, 13(4), 1234–1247.

Assembe-Mvondo, S., Putzel, L., & Eba'a Atyi, R. (2021). *Governance of Forests and Land in West and Central Africa: Trends, Challenges, and Recommendations*. CIFOR Occasional Paper.

Braun, V., & Clarke, V. (2006). *Using Thematic Analysis in Psychology*. Qualitative Research in Psychology, 3(2), 77–101.

Bryman, A. (2016). *Social Research Methods* (5th ed.). Oxford University Press.

Chen, M. A. (2012). *The Informal Economy: Definitions, Theories and Policies*. WIEGO Working Paper.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Demirbas, A. (2004). *Combustion Characteristics of Different Biomass Fuels*. Progress in Energy and Combustion Science, 30(2), 219–230.

Ekpo, U., & Essien, E. (2018). *Rural Resource Utilization and Agro-Waste Innovation in Nigeria*. Nigerian Journal of Renewable Energy.

Etikan, I., & Bala, K. (2017). *Sampling and Sampling Methods*. Biometrics & Biostatistics International Journal, 5(6), 00149.

Gyamfi, S., Adom, P., & Abdulai, I. (2023). *Bioenergy Transitions in West Africa: Policy and Practice*. Energy Policy Journal.

IEA Bioenergy. (2022). *Biomass Supply Chains for Sustainable Bioenergy Production*. International Energy Agency.

International Energy Agency (IEA). (2022). *Africa Energy Outlook 2022*.

International Renewable Energy Agency (IRENA). (2021). *Renewable Energy Market Analysis: Africa and Its Regions*.

Inyang, I. N., Digha, O. N & Ikono, E. C. (2021). Evaluation of Flora Species Diversity In Urban Formations of Calabar, Cross River State, Nigeria. British Journal of Environmental Sciences. Vol.9, No.2, Pp. 32-47, 2021. Issn 2054-6351 (Print), Issn 2054-636x (Online).

Musa, M., Ajayi, J., & Olatunji, O. (2022). *Informal Bioeconomy and Youth Livelihoods in Nigeria: A Sectoral Analysis*. African Journal of Development Research, 17(3), 88–104.

NESP (Nigeria Energy Support Programme). (2020). *Biomass and Waste-to-Energy Policy Review*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Obi, C. (2010). *Oil Extraction, Dispossession and Resistance in the Niger Delta*. Canadian Journal of Development Studies, 30(1–2), 219–236.

Ogunbode, T. O., & Olowu, D. (2020). *Community Voice and Environmental Justice in West African Natural Resource Sectors*. Journal of African Public Policy.

UN Women. (2021). *Gender and Energy in Sub-Saharan Africa: Barriers and Policy Solutions*.

UNDP. (2023). *Policy Brief on Biomass, Circular Economy and Inclusive Growth in Sub-Saharan Africa*.

Watts, M. (2008). *Curse of the Black Gold: 50 Years of Oil in the Niger Delta*. PowerHouse Books.

World Bank. (2022). *Nigeria: Resource Governance and Inclusive Development Report*. Washington, DC.