

Community perceptions and lived experiences of charcoal production: Environmental and health implications in Kintampo, Ghana

Prince Bioh¹
Manual Selvaraj Bexci²

¹princebioh@yahoo.com

²bexci@lincoln.edu.my

^{1,2} Lincoln University College, Malaysia

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ABSTRACT

Supported by the Environmental Kuznets Curve Theory (EKCT), charcoal production is an important economic activity for rural communities and a key energy source for urban areas. However, the environmental and health effects are increasingly being questioned. This study explored the socio-economic benefits, environmental impacts, health effects, and community perceptions of charcoal production in the Kintampo area of the Bono East Region using a qualitative approach. The target population comprised approximately 200 residents of Kintampo, including community members, charcoal producers, local authorities and other stakeholders directly or indirectly involved in the charcoal value chain. A stratified purposive sampling technique was used, whereby the population was first stratified by gender and age group before participants were purposively selected within each stratum, yielding a sample of 12 participants, comprising four older women, four men and four youth, for the study. Data collection was done through in-depth interviews and focus group discussions with charcoal producers, farmers, community members and local authorities. Thematic analysis yielded five main themes, namely socio-economic benefits, environmental impacts, awareness of policies and regulations, health and agricultural implications, and community perceptions and attitudes. The results indicate that charcoal production is an important source of income and employment, satisfying household needs and bolstering local trade networks. At the same time, negative impacts such as deforestation, biodiversity loss, soil erosion and reduced agricultural productivity were observed. Health hazards such as lung and eye diseases were frequently mentioned. Although respondents were aware of existing regulations, they identified weak enforcement and a tendency for economic considerations to trump compliance with regulations. The participants expressed a willingness to use alternative sources of energy if they were affordable and easy to access, illustrating the dilemma between economic survival and ecological sustainability. Integrated interventions including improved technologies, livelihood diversification, community education, strengthening of policy enforcement and access to cleaner energy alternatives for sustainable charcoal production in Kintampo are recommended. The findings offer useful insights for policymakers, development agencies and local stakeholders to reconcile rural livelihoods with environmental conservation and public health goals.

Keywords: Charcoal Production, Community Perceptions, Environmental Impact, Health Risks, Qualitative Study, Livelihoods

I. INTRODUCTION

Charcoal production has become a critical socio-economic and environmental issue in Ghana, located at the intersection of energy access, rural livelihoods and environmental sustainability. Over the past two decades, rapid urbanisation, population growth and increasing energy demand have resulted in an increasing reliance on charcoal, particularly in urban and peri-urban areas. Charcoal has become the dominant fuel for cooking for millions of Ghanaians, mainly due to its affordability, availability and convenience compared to alternatives such as liquefied petroleum gas (LPG) and electricity, which remain expensive or irregularly supplied for many households (Akom et al., 2020). In rural communities, the traditional use of firewood is slowly being supplemented or replaced by charcoal due to its longer burn time, lower smoke emissions and cleaner handling properties. These features make charcoal particularly attractive for small-scale commercial food preparation and for households wishing to minimise indoor air pollution and associated health risks. Economically, charcoal production is an important income-generating activity for many thousands of rural households in Ghana, especially in the savannah and transitional forest zones.

The value chain from tree felling and carbonisation to transport and retail is largely informal but supports a significant number of actors, including women who dominate urban retail markets. The sector offers critical financial support during agricultural off-season or periods of economic hardship, but its informal nature often leads to poor labour conditions, weak environmental regulation and land degradation from unsustainable harvesting practices. The sector is anticipated to generate 400,000 direct and indirect employment opportunities in Ghana (Brobbe et al., 2019).

Environmentally, the rising demand for charcoal has been linked to deforestation, loss of biodiversity, soil erosion and local climate change, especially where tree harvesting is unregulated (Aabeyir & Agyare, 2020). The traditional earth-mound kilns used for carbonisation are inefficient and emit significant greenhouse gases, thus contributing to environmental degradation and contradicting Ghana's commitments to sustainable land management and climate resilience (Arko et al., 2024; Iiyama et al., 2017). These challenges highlight the urgent need for integrated solutions that address energy demands, rural development, and environmental preservation. Kintampo in the Bono East Region has become a significant site for charcoal production (Aabeyir & Agyare, 2020).

The prevalence of activities in this area reflects Ghana's wider development dilemma: while charcoal production offers a pathway to poverty alleviation and support for rural livelihoods (Agyeman et al., 2012), its practices are unsustainable and contribute to ecological devastation, undermining the very resources communities depend on (Arko et al., 2024; Iiyama et al., 2017). The largely informal nature of the charcoal economy further complicates regulation and the promotion of sustainable practices (Sola et al., 2019). Despite global progress in energy alternatives, charcoal remains a primary energy source for households, especially in areas where electricity and LPG are prohibitively expensive or unreliable (Karakara et al., 2021). In this context, Kintampo municipality serves as an interesting case study to explore the qualitative dimensions of charcoal production. Understanding communities' perceptions, lived experiences and socio-environmental impacts is crucial for developing contextually appropriate policies that balance economic needs and environmental sustainability.

1.1 Statement of the Problem

Despite global progress toward cleaner energy transitions, charcoal remains the primary cooking fuel for most households in Sub-Saharan Africa, including Ghana, where approximately 80% of urban households and over 90% of rural households depend on charcoal or firewood for daily energy needs (Tazebew et al., 2023). In regions such as the Bono East Region of Ghana, charcoal production is not merely an energy practice; it is a deeply embedded livelihood strategy sustaining household incomes, employment, and food security, particularly during agricultural off-seasons. However, this economic dependence comes at a significant cost: deforestation, biodiversity loss, soil degradation, reduced agricultural productivity, and serious respiratory and eye health risks associated with prolonged smoke exposure.

The Kintampo area of the Bono East Region presents a particularly acute manifestation of this dilemma. The municipality has been identified as a significant and intensifying site of charcoal production activity, yet it has received limited focused empirical attention. Existing research in Ghana and Sub-Saharan Africa has predominantly relied on quantitative or mixed-methods approaches, generating important aggregate data but leaving community-level perceptions, lived experiences, and cultural framings of charcoal production largely undocumented. The voices of producers, farmers, women traders, and local authorities the very actors whose decisions shape the trajectory of forest use are largely absent from the evidence base informing policy.

Furthermore, existing regulatory frameworks such as Ghana Forest and Wildlife Policy of 2012 have demonstrated limited effectiveness in managing unsustainable charcoal production, due in part to enforcement gaps, institutional resource constraints, and the structural economic dependence of communities on the charcoal value chain (Ministry of Lands and Natural Resources, 2012). Without understanding how communities perceive environmental change, engage with regulations, experience health consequences, and conceptualise alternatives, policy interventions risk being technically sound but socially ineffective. This study therefore addresses three interconnected gaps: the absence of community-centred qualitative evidence from Kintampo specifically; the limited integration of health, livelihood, environmental, and governance dimensions within a single analytical framework; and the need to critically examine whether the theoretical optimism of the Environmental Kuznets Curve that rising incomes will eventually reduce environmental degradation holds in a context characterised by institutional weakness, limited access to clean energy alternatives, and structural poverty-environment traps. Understanding these dimensions is essential for developing interventions that are contextually appropriate, equitable, and capable of reconciling rural livelihoods with environmental conservation and public health goals.

1.2 Research Objectives

- i. To determine the perceptions and attitudes of residents in Kintampo regarding charcoal production and its impact on the physical environment, health, and local livelihoods.
- ii. To assess the socio-economic benefits and challenges associated with charcoal production for community members and local stakeholders in Kintampo.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 The Environmental Kuznets Curve Theory (EKCT)

The Environmental Kuznets Curve Theory (EKCT) is the main theoretical framework used in this study to examine the relationship between charcoal production, economic livelihoods and environmental degradation in Kintampo, Ghana. The EKC was first made famous by Grossman and Krueger (1991) in their seminal study on the environmental effects of NAFTA and postulates an inverted U-shaped relationship between per capita income and various measures of environmental degradation; as an economy grows and incomes increase, environmental pressure increases; but after reaching a certain income level the turning point further economic growth results in decreasing environmental degradation (Agboola & Bekun, 2019). Panayotou (1994) later formalized and expanded this paradigm to include a range of environmental indicators such as deforestation, air pollution and soil degradation. The theoretical basis of the EKC is founded on three interconnected dynamics: the scale effect (initial stages of income growth where conservation is not prioritised); the composition effect (changes in economic structure towards cleaner service-based sectors) and the technique effect (investment in cleaner technologies, as populations grow wealthier and demand better environmental governance) (Stern, 2004). The EKC is therefore not a simple, automatic economic trajectory but a theoretically contingent process, heavily dependent on the institutional, political and governance context within which economic development is taking place (Stern, 2017). In the context of charcoal production in Kintampo, communities are situated on the early, rising side of the hypothetical EKC curve; a phase where income generation and environmental exploitation are closely linked, and resource extraction is structurally embedded in daily survival (Appiah et al., 2009). Critically, there is no inherent mechanism by which income growth from charcoal production will automatically generate the compositional or technique effects the EKC predicts. In the absence of effective institutional governance, access to alternative livelihoods, and affordable clean energy technologies, rising incomes from charcoal production are as likely to intensify forest extraction as to reduce it (Lambin & Meyfroidt, 2011). The EKCT, therefore, functions in this study not as a predictive model to be confirmed but as a critical analytical framework against which the lived realities of charcoal producers can be examined and theoretically elaborated.

Relevance of the EKC to Charcoal Production and Deforestation: The application of the EKC to deforestation and biomass extraction has generated substantial debate. (Rudel et al., 2005) identified a 'forest transition' pattern analogous to the EKC prediction in some countries; however, Lambin & Meyfroidt (2011) demonstrated that forest recovery in higher-income countries has frequently been achieved by displacing deforestation to lower-income tropical and subtropical regions, directly relevant to Kintampo, given Ghana's role as a regional charcoal supplier. Research in Sub-Saharan African contexts has further questioned whether EKC turning points might ever occur in low-income, biomass-dependent economies Yameogo and Dauda (2022) found that the estimated turning point for many African economies was at income levels far beyond current levels, effectively placing the optimistic long-run empirical implication of the theory beyond reach without deliberate policy intervention.

2.2 Empirical Review

2.1.2 Methods of Charcoal Production

The production of charcoal has been an essential part of human survival for years, playing important roles in cooking, heating, and metallurgy, and serving as an alternative source across many aspects of human development. There are various methods of making charcoal, ranging from traditional earth pits to modern advanced methods. The methods for charcoal production depend on several factors, such as the resources available and technological advancement. Modern methods, such as the brick kiln, Metal kiln, and Retort kiln, are used in developed countries. The traditional methods of charcoal production are the earth mound kiln and the pit kiln.

In the earth-mound method, the logs are cut into sizes, stacked in a conical shape and covered with earth layers, leaves, or grass and soil. A small fire outlet is created to start the fire and later covered with leaves, grass and soil. The kiln are sealed to allow slow, oxygen-limited burning. This process takes several days with constant monitoring during the day and night. It is seen as less expensive; simple tools are needed to start and are easily available in rural communities. On the other hand, the method is less efficient, produces a lot of smoke and pollutants, yields low charcoal, destroys the earth and vegetation covered and living organisms, with associated health problems for the producers (Tazebew et al., 2023). The Pit kiln is like the earth mound method, just that it is labour-intensive. A pit is dug in the ground, filled with stacked wood, covered with leaves and grass and finally with soil.

These traditional methods of charcoal production remain in use in many parts of Africa, Asia and Latin America, especially where the modern method of charcoal production is limited; it's gradually phasing out due to environmental concerns (PNP Global Supply, 2025). The advanced methods produce more charcoal in demand and are environmentally friendly, but expensive to set up compared to the traditional methods of charcoal production.

Charcoal as a Livelihood and Energy Source in Sub-Saharan Africa: Charcoal occupies a structurally central position in the energy systems of Sub-Saharan Africa. More than 700 million people in the region depend on wood fuel as their primary energy source for cooking and heating (2019) and this is projected to increase through 2030 as the population grows faster than the adoption of cleaner energy sources. In Ghana alone, about 80% of urban households and over 90% of rural households rely on charcoal or firewood for cooking (2014), indicating the continued unavailability of LPG and electricity. Charcoal production is not just an energy source for communities like Kintampo; it is a fundamental livelihood strategy embedded within complex household economies. Brobbey et al. (2019) found that charcoal production accounted for 40% to 70% of the household incomes of active producers in the Brong-Ahafo Region, highlighting the structural challenge of replacing it without significant external support. The literature consistently documents a gendered dimension to livelihoods related to charcoal. Although the physical production process of tree felling, kiln construction, burning and bagging is predominantly male, women assume important roles in transport, marketing and retail, and often face disproportionate health risks from exposure to dust and handling of charcoal (Njenga et al., 2013; Armah et al., 2015) documented that women in charcoal-trading households in Ghana's forest-savannah transition zone reported higher rates of respiratory symptoms than either male producers or non-charcoal households, a finding attributed to prolonged exposure during weighing, handling, and cooking with charcoal in poorly ventilated domestic spaces.

Environmental Consequences of Charcoal Production: The environmental literature consistently identifies deforestation as the primary consequence of charcoal production. In tropical Sub-Saharan Africa, wood fuel harvesting accounts for 30–60% of deforestation, a major driver of land-cover changes and biodiversity loss (Köhl et al., 2015). In Ghana, the Forest Commission (2019) reported that the transitional forest zones of Brong-Ahafo, Northern, and Savannah Regions, all significant charcoal-producing areas, experienced the highest rates of forest cover loss over the preceding decade. In addition to deforestation, Zulu & Richardson (2013) estimated that conversion efficiencies of artisanal kilns are only 10–25%, leading to disproportionately high greenhouse gas emissions per unit of energy delivered. Dodoo et al., (2023) found that areas with high charcoal production intensity in Ghana's transitional forest zone showed significantly elevated rates of soil organic matter loss and reduced infiltration capacity, creating a feedback dynamic where degraded soils further reduce agricultural productivity and thus reinforce economic dependence on charcoal.

Evidence on Deforestation and Environmental Degradation: The mixed-methods approach of satellite land-cover analysis, household surveys ($n = 320$), and qualitative interviews in the Brong-Ahafo Region of Ghana (Brobbey et al., 2019). High-intensity charcoal communities lost, on average, 23% more trees cover over 15 years (2003–2018) than low-intensity communities, controlling for rainfall and slope. Community members described the retreat of forest boundaries, loss of economically important tree species, and increasing distances to productive harvesting areas. Dodoo et al., (2023) reported significantly degraded soil quality indicators on charcoal-producing territories in the savannah transition zone of Ghana, with the strongest impacts in areas with more than ten years of continuous production. This study provided empirical data on community perceptions of land degradation. Appiah et al. (2009) found that 78% of surveyed producers perceived forest decline and 65% linked it directly to charcoal production, yet fewer than 20% had changed their practices, citing economic necessity and the absence of viable alternatives as the primary reasons, a finding of 'awareness-without-agency' that is analytically central to the present study.

2.2.2 Health Implications of Charcoal Production and Use

The (2021) estimates that household air pollution from solid fuel combustion including charcoal, is responsible for approximately 3.8 million premature deaths annually worldwide, with Sub-Saharan Africa bearing a disproportionate share. Armah et al., (2015) found that mean 24-hour PM_{2.5} concentrations in charcoal-using households in Ghana's Brong-Ahafo Region exceeded 200 $\mu\text{g}/\text{m}^3$ during cooking periods more than seven times the WHO 24-hour guideline of 25 $\mu\text{g}/\text{m}^3$. Brobbey et al., (2019) reported that over 60% of interviewed charcoal producers described chronic respiratory symptoms. Occupational health risks for charcoal producers include respiratory exposure to smoke and particulate matter, skin and eye exposure to ash and combustion by-products, and musculoskeletal injury from heavy physical labour. Community perceptions of these risks are shaped by economic necessity, cultural framing and awareness of causal pathways, with producers tending to normalise smoke-related symptoms as occupational inconveniences (Amoah et al., 2024).

Community Perceptions, Governance and Policy Context: Studies consistently find that communities are aware of forest depletion, noting observable changes in tree cover, stream flow, and microclimates over their lifetimes (Brobbey et al., 2019; Appiah et al., 2009). However, the relationship between environmental awareness and behavioural change is not simple. Dodoo et al., (2023) discovered that even among producers who were highly concerned about the depletion of forests, the structural constraints of poverty and lack of alternatives rendered voluntary reduction individually irrational. The regulatory architecture of Ghana, as articulated in the Forest and Wildlife Policy of 2012 and the Timber Resources Management Act of 1997, reveals a significant gap between formal institutional ambition

and practical enforcement capacity: the administrative reach of the Forestry Commission in rural areas such as Kintampo is limited by inadequate staffing and financial resources (Kiptot & Franzel, 2012). The National Charcoal Policy, still under development at the time of this study, aimed to formalise the sector through licensing and improved kilns; however, critics warn that, without addressing structural livelihood pressures, it risks criminalising subsistence producers rather than incentivising sustainable production.

Evidence on Health Impacts: As documented, charcoal-using households in Ghana's Brong-Ahafo Region had significantly higher rates of physician-diagnosed chronic obstructive pulmonary disease (COPD) and acute lower respiratory infection in children under five compared to LPG-using households, one of the more methodologically rigorous pieces of Ghanaian evidence, given its combination of objective pollution monitoring and clinical health assessment (Armah et al., 2015). According to Njenga et al. (2013), who studied charcoal producers in Kenya and Tanzania, found significant spirometric evidence of obstructive lung function patterns in producers with more than five years of active experience. Producers in focus groups framed respiratory symptoms as a normal occupational experience rather than a health risk requiring attention, a perception shaped by economic necessity, limited healthcare access, and the normalisation of smoke exposure. Amoah et al., (2024) in Ghana found that although 71% of surveyed households had reported chronic respiratory symptoms attributed to charcoal smoke, less than 35% had sought formal medical care, with cost, distance and low perceived severity as the main barriers.

Bhattarai and Hammig (2001) found EKC-consistent deforestation patterns in Latin America and Asia-Pacific countries, but not Sub-Saharan Africa, which they attributed to poor institutional quality, lack of secure land tenure, and limited policy capacity in this African exception. This was also confirmed by Yameogo and Dauda (2022) for fifteen African economies (1990–2012), where the estimated income turning points were estimated to be two to four times the observed maximum income levels, effectively beyond any plausible near-term development trajectory. Most directly relevant to this study, Antwi Baafi et al. (2025) found a positive and significant association between charcoal production output and forest cover loss at Ghana's district level (2007–2020) with no evidence of a turning point, concluding that deliberate policy-led structural change is needed. Three significant research gaps remain: (1) existing studies lack qualitative, community-centred perspectives capturing lived experiences and cultural framings; (2) Kintampo specifically has not been the focus of empirical investigation; and (3) no published study has integrated community perceptions, health implications, and EKC analysis at the community level in Ghana.

III. METHODOLOGY

3.1 Research Design

This study adopted a qualitative case study design to explore the experiences, perceptions, and attitudes of communities regarding charcoal production in Kintampo, Bono East Region, Ghana. The qualitative approach was deemed appropriate because it allows an in-depth understanding of complex social phenomena, particularly how residents interact with, perceive, and are affected by charcoal production that cannot be adequately measured through quantitative methods. By emphasising participants' perspectives, the study captures the socio-economic, environmental, and health-related dimensions of this livelihood activity in a contextually grounded manner.

3.2 Study Area

This study was carried out in Kintampo, which was selected as the study area owing to high levels of charcoal production and local households' dependence on charcoal for their livelihoods. As documented, charcoal making is associated with environmental impacts such as deforestation, soil degradation, soil erosion and loss of biodiversity (Alhassan et al., 2023).

3.3 Target Population

The target population of this study was approximately 200 residents of Kintampo, comprising community members, charcoal producers, local authorities and other stakeholders who were directly or indirectly involved in the charcoal value chain.

3.4 Sampling and Sample Size

A stratified purposive sampling technique was adopted to select participants with rich knowledge and lived experience of charcoal production. The target population was first stratified into three subgroups, namely older women, men and youth, to ensure that the perspectives of key demographic groups within the charcoal value chain were captured. Participants were then purposively selected within each stratum based on inclusion criteria requiring that they reside in Kintampo, be actively engaged in charcoal production or trade, and possess knowledge of local environmental and socio-economic conditions. From the target population of approximately 200 residents, a total sample of 12 participants was selected, comprising four older women, four men and four youth, to ensure diverse perspectives across gender and

age groups within the charcoal value chain. The sample also included representatives of the Municipal Assembly and local environmental agencies to capture institutional perspectives.

3.5 Data Collection Instruments and Procedures

Data were collected using a range of qualitative methods to ensure triangulation and improve the credibility of the findings: (1) In-depth Interviews (IDIs): Semi-structured interviews were used to examine the experiences, perceptions and knowledge of charcoal production, its socio-economic benefits and environmental and health impacts. IDIs were conducted with community members, local officials and the producers of charcoal. (2) Focus Group Discussions (FGDs): FGDs were organised with separate groups of men, women and youth to ensure diverse perspectives on collective experiences, shared concerns and attitudes towards charcoal production. (3) Observations: Direct field observations of charcoal production sites, kilns, deforested areas, and market activities were carried out to contextualise interview and discussion data, with field notes documenting environmental conditions and production methods.

3.6 Data Analysis

Data were analysed using thematic analysis following Braun and Clarke (2006) six-step approach: familiarisation with data, coding, generating initial themes, reviewing themes, defining and naming themes, and producing the final report. Audio-recorded interviews and FGDs were transcribed verbatim, and field notes were integrated into the analysis to enrich contextual understanding.

Trustworthiness was ensured through triangulation of methods, member checking (where participants reviewed summaries of their responses), and peer debriefing. Detailed contextual descriptions enhanced transferability, while an audit trail ensured dependability.

3.7 Ethical Consideration

Ethical approval was obtained from the relevant institutional review board. Informed consent was sought from all participants, who were informed of their right to withdraw, and pseudonyms were used throughout reporting.

IV. FINDINGS & DISCUSSION

4.1 Findings

A thematic analysis of in-depth interviews and focus group discussions with a sample of 12 participants (four older women, four men and four youth) revealed five major, interrelated themes that give rich insights into the socio-economic, environmental and health dimensions of charcoal production in Kintampo. These themes align directly with the study's two research objectives. Theme 1 (Economic Benefits) responds to the second objective, which sought to assess the socio-economic benefits and challenges of charcoal production for community members and local stakeholders. Themes 2 to 5 (Environmental Impact; Awareness of Policies and Regulations; Health, Food Production and Farming Impacts; and Community Perceptions and Attitudes) respond to the first objective, which sought to determine residents' perceptions and attitudes regarding the impact of charcoal production on the physical environment, health and local livelihoods. Within this framework, charcoal production practices function as the central explanatory factor, while environmental degradation, health outcomes and livelihood outcomes represent the key outcomes examined across the themes below, and each theme is discussed in relation to the reviewed literature in section 4.2. These themes directly address the study's two research objectives: Theme 1 (Economic Benefits) responds to the second objective, which sought to assess the socio-economic benefits and challenges of charcoal production for community members and local stakeholders, while Themes 2 to 5 (Environmental Impact, Awareness of Policies and Regulations, Health and Farming Impacts, and Community Perceptions and Attitudes) respond to the first objective, which sought to determine residents' perceptions and attitudes regarding the impact of charcoal production on the physical environment, health, and local livelihoods. Within this structure, charcoal production practices function as the central explanatory factor examined throughout the study, while environmental degradation, health outcomes, and livelihood and economic outcomes represent the key outcome dimensions against which community perceptions and lived experiences are analysed.

Theme 1: Economic Benefits: Participants consistently noted the production of charcoal as a critical livelihood strategy that provides income, employment and economic resilience. Many households rely on it to meet daily needs, support education and pay for healthcare. A female producer said:

"If I do not make charcoal, I cannot feed my children or send them to school. This is the only work I know, and it keeps my family alive." A local assembly member added, "Charcoal brings money to the community. Many young men and women depend on it when farm work is slow, especially during the dry season." (15th October 2025, Kintampo).

The longer value chain of transporters, market vendors and artisans was also observed by participants and women mentioned charcoal retailing as a source of financial independence:

Selling charcoal helps me to pay for school fees and household needs. I have some control over money, which I cannot get from farming alone (Qualitative survey, 15th October 2025, Kintampo).

Theme 2: Environmental Impact: Environmental degradation was a major concern. Respondents reported widespread deforestation, loss of biodiversity, soil erosion and changing patterns of local climate. One male farmer said, *"We see every year more trees cut down. The soil becomes weak and our farms produce less. Birds and animals are disappearing too."* A female community member added, *"The land is dry and bare in some places where charcoal is made. It used to be green and fertile, but now it's difficult to farm."* (15th October 2025, Kintampo).

Focus group discussions indicated a general awareness of changes in rainfall patterns, drying water sources, and reduced availability of forest products. A senior male producer noted:

"We know we are cutting too many trees, but the kilns we use are what everyone has. There is no other way to make charcoal cheaply" (Respondents, 15th October 2025, Kintampo).

This statement highlights the community's ecological awareness, but also the structural lock-in that prevents behavioural change.

Theme 4: Awareness of Policies and Regulations: The study found different levels of awareness of forestry laws and environmental regulations, but enforcement was generally seen as weak, inconsistent or biased towards economic interests. A young male producer remarked,

"We know there are rules, but no one checks. If we stop making charcoal, we will not survive."

A local official acknowledged:

"The laws exist, but we lack the manpower and resources to enforce them. People's livelihoods depend on charcoal, so strict enforcement is difficult." (15th October 2025, Kintampo).

Informal arrangements, such as paying the local chief to access the forest, were often mentioned as an alternative to formal regulation.

The community members were frustrated by the lack of practical orientation: We hear about rules from time to time, but no one teaches us how to produce charcoal without harming the forest. We just follow what we know." (Qualitative Survey, 15th October 2025, Kintampo).

Theme 5: Health, Food Production and Farming Impacts: Participants repeatedly talked about serious health risks associated with long-term smoke exposure. One female participant said,

"I cough a lot when we are burning the charcoal and my eyes burn. Sometimes it feels hard to breathe. We get headaches too, but we have no choice because this is our income." (15th October 2025, Kintampo).

A local health worker corroborated:

"We have noticed more cases of respiratory infections in communities where charcoal production is high. Women and children are especially affected because they spend more time near the smoke."

Charcoal production also affected agricultural productivity through labour diversion and land degradation. A male farmer noted,

"Many young men who should be working on the farms go to cut trees for charcoal. Our harvests are smaller now, and the soil is poor. Sometimes we cannot plant enough food to feed our families." (Respondents, 15th October 2025, Kintampo).

Participants associated ongoing production with ongoing food insecurity, less crop diversity, and lower agricultural resilience.

Theme 6: Community Perceptions and Attitudes: Community perceptions were complex and nuanced. Participants acknowledged the economic necessity of charcoal production but were increasingly aware of its negative environmental and health consequences and expressed conditional openness to alternatives. A female respondent said,

"We like charcoal because it is cheap and easy, but we know it is killing the forest. If we could get gas or solar, we would use them." (Respondents, 15th October 2025, Kintampo).

A male youth participant added,

"Charcoal is our life, but we also see the harm. Maybe we need a better way to make a living without cutting so many trees. We need help from the government or NGOs." (15th October 2025, Kintampo).

Participants also expressed concern about intergenerational impacts, with one older producer commenting:

"I know my children will have less forest and land to farm if this continues. But what else can we do? We only know charcoal, and it feeds us now." (Respondents, October 2025, Kintampo).

This theme highlighted the fundamental tension between economic survival and environmental stewardship, and the promise of participatory interventions designed with community input.

4.2 Discussion

The study revealed the complex interplay of socio-economic benefits, environmental degradation, health impacts, and community perceptions associated with charcoal production in Kintampo. Consistent with evidence from similar Sub-Saharan African contexts on its importance as a critical economic buffer during agricultural off seasons (Mwampamba et al., 2013; Afrane & Ntiamoah, 2012), charcoal production emerged as a critical livelihood strategy for many households. However, the informal and seasonal nature of the sector highlights its limited potential to provide long-term economic security, underscoring the structural need for sustainable livelihood diversification.

The findings on environmental degradation are in line with earlier studies carried out in Ghana and Sub-Saharan Africa, showing that charcoal production is a major cause of deforestation and soil degradation (Peprah et al., 2017; Mencarelli et al., 2023). Crucially, the feedback loop whereby declining soil fertility and reduced agricultural yields deepen economic dependence on charcoal observed directly in community narratives is consistent with the EKC's framing of early-stage environmental degradation as structurally embedded in livelihood necessity, and with (Dodoo et al., 2023) empirical findings on soil degradation in Ghana's transitional forest zone. This feedback loop suggests that without structural change, environmental degradation associated with charcoal production is more likely to increase than diminish. Regarding governance, the study found that current regulatory regimes are generally ineffective in managing unsustainable practices due to institutional issues and the economic importance of charcoal for local communities (Amponsah et al., 2026). Health and agricultural productivity findings reinforce prior research demonstrating that biomass fuel production threatens human health while undermining food security through labour diversion and land degradation (Olarinde & Olusola, 2018; Tadele & Adgo, 2024). Community perceptions reflect the fundamental tension between survival and sustainability, highlighting opportunities for behavioural change interventions provided they are affordable, accessible, and culturally appropriate (Yeboah & Kappler, 2019). Taken together, the evidence and community narratives suggest that the structural conditions required for an EKC-type income-environment turning point, institutional effectiveness, alternative livelihoods, and affordable clean energy are absent in Kintampo, making deliberate policy-led structural change essential. It was also observed that charcoal production at Kintampo uses the traditional way of production, which has adversely affected the environment in Africa.

4.3 Implications for Theory and Policy

The study's findings have important theoretical implications for applying the Environmental Kuznets Curve Theory to community-level charcoal production contexts in Sub-Saharan Africa. The community narratives collected in Kintampo provide qualitative grounding for the empirical findings of Bhattarai and Hammig (2001) and Antwi Baafi et al. (2025), all of whom found that the EKC's predicted income-environment turning point does not operate in Sub-Saharan African deforestation contexts. The lived experiences of charcoal producers in Kintampo illustrate precisely the structural dynamics that explain this empirical failure: producers are aware of ecological degradation, desire alternatives, and yet are rationally locked into environmentally damaging livelihoods by the absence of economically viable substitutes, weak institutional enforcement, and limited access to clean energy technologies. This configuration represents a structural poverty-environment trap that the EKC's mechanism of income-driven compositional and technique effects cannot address without deliberate external intervention.

From a policy perspective, the study suggests that single-instrument regulatory approaches such as enforcement-focused forestry policies without accompanying livelihood support are likely to be both ineffective and inequitable in the Kintampo context. The most impactful policy frameworks identified in the literature and consistent with the study's findings are those that simultaneously: (a) provide economically viable alternative livelihoods or income supplements that reduce the structural incentive to produce charcoal; (b) reduce the cost and improve the accessibility of alternative clean energy sources such as LPG and biogas; (c) introduce improved kiln technologies that maintain charcoal production viability while substantially reducing the wood-to-charcoal input ratio; and (d) build community-level institutional capacity for participatory forest management that aligns conservation incentives with livelihood interests. The gendered dimensions of the charcoal value chain also warrant explicit attention in policy design, as women engaged in charcoal retailing and handling face disproportionate health exposures yet have been largely absent from policy formulation processes.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusions

The study has added to the body of knowledge on the economic benefits, environmental, and health implications of charcoal production in Kintampo, Ghana. Charcoal production continues to be an important livelihood activity, providing income, employment, and economic resilience, especially during the agricultural off-season or periods of economic uncertainty. However, the benefits are offset by significant deforestation, loss of biodiversity, soil degradation, reduced productivity of agriculture and substantial respiratory and eye health risks from exposure to charcoal smoke. The study reveals low awareness of existing policies and regulations, weak enforcement of such regulations due to economic dependence and institutional constraints, and the systematic undermining of the optimistic income-environment turning point mechanism of the EKC due to the absence of institutional effectiveness, alternative livelihoods and affordable clean energy in Kintampo. The findings reveal a real tension in community perceptions between economic survival and environmental sustainability, with many residents expressing conditional willingness to adopt alternative energy sources. Overall, the findings suggest the need for integrated, participatory and context-sensitive interventions that address livelihood needs, environmental conservation and public health priorities simultaneously.

5.2 Recommendations

Firstly, promote sustainable charcoal production methods: Encourage the use of more efficient carbonisation technologies such as improved kilns to reduce wood use, greenhouse gas emissions and soil degradation. Support the transition to sustainable methods through technical training and financial incentives. Promote Alternative Livelihood Opportunities: Promote income diversification through agroforestry, beekeeping and small-scale agribusiness and support vocational and skills-training programs targeting youth and women, key actors in the charcoal value chain. Moreover, Public Health and Environmental Awareness Campaigns: Engage local leaders, schools and women's groups in community-based educational campaigns on the health risks of charcoal smoke and the environmental consequences of unsustainable production.

Again, strengthen Policy Implementation and Laws: The corrupt officials and those who compromised the laws should be held accountable, to serve as a deterrent to others. Also, develop institutional capacity, community-based monitoring systems and participatory governance structures that facilitate community input, equitable benefit-sharing and compliance incentives to strengthen enforcement of forestry and environmental laws. Finally, scale up access to clean and affordable energy alternatives: Facilitate access and affordability of LPG, biogas and solar cookstoves through financing schemes, subsidies or microcredit programs to allow rural and urban households to transition to cleaner energy without compromising livelihoods.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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