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PERCEIVED HAZARDS ASSOCIATED WITH CHARCOAL PRODUCTION IN SOUTHWESTERN, NIGERIA

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ABSTRACT: Indiscriminate cutting of trees for charcoal production has resulted in land degradation, erosion, air pollution as well as climate change which are detrimental to human health. Therefore, this study investigated the perceived hazards associated with charcoal production in Southwestern, Nigeria. The target population for this study included all charcoal producers in Southwestern Nigeria. A multistage sampling technique was utilized to select 381 respondents from the region. The study examined the socio-economic profiles of charcoal producers, explored the methods used in charcoal production, identified perceived risks involved in the production process, and investigated the strategies employed to manage these hazards. Data were analyzed using descriptive statistics such as frequency, percentages, means, Weighted Mean Scores (WMS), and standard deviations. Inferential statistics, including Chi-square tests and Pearson Product Moment Correlation (PPMC), were applied to test the research hypotheses. Earthen mound method of charcoal production was the most (84.25%) used method in charcoal production across the states. The hazards experienced by charcoal producers in order of importance were spinal cord disorder (WMS = 4.87), respiratory diseases (WMS = 4.8), skin and respiratory tract irritation and infection (WMS = 4.65). Unavailability of health care facilities (WMS = 4.36), unstable

government policy in charcoal production, forest guard (WMS = 1.91) and unpredictability of returns from charcoal (WMS = 1.87) were constraints limiting strategies to manage the hazards. The PPMC analysis showed significant relationships between age (p = 0.050), years of formal education (p = 0.012), income from primary occupation (p = 0.021), household size (p = 0.046), years of experience in charcoal production (p = 0.041) and perceived hazards associated with charcoal production. Conclusively, charcoal production had impacted negatively on the health status of the charcoal producers. The study therefore recommended the use of appropriate safety measures to mitigate the effects of hazards associated with charcoal production.

Keywords: *Perceived, Hazard, Health Hazard, Environmental Hazard, Charcoal Production.*

INTRODUCTION

Forests have long served as a critical source of energy for human societies. Traditional forest-based biofuels, such as firewood and charcoal, continue to be widely used for cooking and heating, especially in many regions of the world (Global Forest Atlas, 2017). According to the Global Forest Atlas (2017), the production of charcoal is rising in developing countries, while demand continues to grow in international markets. Charcoal, a key type of wood fuel, is produced from wood materials—including trunks, branches, and other tree and shrub components—through a process of controlled burning. As described by Jamala et al. (2013), charcoal is the dark grey residue primarily composed of carbon and some residual ash, resulting from pyrolysis: the slow heating of wood in an oxygen-limited environment. This process yields a carbon-rich, though impure, fuel source containing ash. It is an excellent domestic fuel, and can be made from virtually any organic material like wood, it has been reported that hardwood species like Acacia, Mangroves and etc. are preferred for charcoal production (Kammen *et al.* 2005).

Charcoal been an old source of energy is as well still a modern source of energy for cooking in both rural and urban centers. According to Kammen et al. (2005), approximately half of the global population relies on charcoal for cooking. In 2002 alone, global charcoal consumption reached 24 million tonnes, with developing countries responsible for nearly all of it. Africa alone accounted for about 50 percent

of that usage. Adeniji et al. (2015) noted that in many developing countries, charcoal remains a dependable, accessible, and affordable energy source for cooking. Although electricity and gas are generally considered the preferred energy sources in urban settings, the high cost of both the fuels and the necessary appliances makes them unaffordable for most low-income households, prompting many to rely on charcoal for household energy needs.

The significance of charcoal as an energy source is evident in both domestic and industrial contexts. Bada et al. (2009) estimated that around 2.4 billion people globally depend on traditional biomass, primarily for cooking and heating. Beyond its energy function, charcoal also plays a key socioeconomic role. It generates income through local trading activities in both rural and urban areas, supporting small-scale retail and wholesale ventures (Eniola et al. 2018). Charcoal is widely regarded as the most commercially important wood-derived fuel—it is smokeless, can be used efficiently in inexpensive stoves, and produces more heat than raw wood (Akinbami, 2001).

The ongoing trend of charcoal production poses several adverse environmental consequences that are already evident and are likely to worsen if not addressed. These include increased soil erosion, a reduction in available biomass for various uses, and the decline of valuable traditional forest products such as fruits, nuts, and medicinal plants. Eniola (2018) noted that despite existing federal regulations aimed at curbing illegal tree felling, the number of charcoal producers and the volume of production continue to rise. The uncontrolled harvesting of trees for charcoal has led to significant land degradation, soil erosion, air pollution, and contributes to climate change—factors that ultimately have detrimental effects on human health. Excessive heat posed by cutting of trees has serious implications for environment and health. Various forms of injuries and health hazards such as respiratory diseases, headaches are also associated with charcoal production, this study therefore examines the perceived hazards associated with charcoal production in southwestern, Nigeria. Therefore, the study provides answers to the following research questions:

i. What are the socio-economic characteristics of charcoal producers in southwestern, Nigeria?

ii. What are the methods used for charcoal production and the activities involved in charcoal production?
iii. What are the perceived hazards associated with charcoal production?
iv. What are the methods used to manage hazards associated with charcoal production?

Aim and objectives of the study

The aim of the study is to examine the perceived hazards associated with charcoal production in Southwestern, Nigeria. The specific objectives were to:

i. describe the socioeconomic characteristics of charcoal producers.
ii. examine the methods used for charcoal production and the activities involved in charcoal production.
iii. determine the perceived hazards associated with charcoal production.
iv. identify the methods used to manage hazards associated with charcoal production, and

Hypotheses of the Study

The hypotheses of the study were stated in null form as follows:

$H0_1$: There is no significant relationship between selected socio-economic characteristics of the charcoal producers and perceived hazards associated with charcoal production.

$H0_2$: There is no significant relationship between methods used in charcoal production and perceived hazards associated with charcoal production.

Methodology

The study was conducted in the Southwestern geopolitical zone of Nigeria, which comprises six states: Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti. Among these, Oyo, Osun, and Ogun states were purposively selected based on their high level of charcoal production activities. A multistage sampling technique was employed to select participants from both registered and unregistered charcoal producers. In total, a sample size of 381 charcoal producers was drawn from the target population for the study.

Results and Discussion

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

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

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

Years Spent in School: From Table 1, 32.28% of respondents had 1–6 years of schooling, 12.60% had 7–12 years, 12.60% had no formal education, and only 1.84% had more than 12 years of schooling, with an average of 11 years of education. These findings indicate varying educational backgrounds among charcoal producers in the study area. Education plays a crucial role in the ability to understand and manage the risks associated with charcoal production. As Kumar (2012) noted, limited literacy

among rural populations often hinders awareness of the environmental consequences of excessive forest exploitation, with many focusing solely on the economic benefits.

Household Size: also, below average (46.72%) of the respondents had between 5-10 members in their household, 38.85% had above 10 members in their household while 14.44% had less than five 5 members in their household. The mean household size in the study area was revealed to be 9 members. This result is an indication that southwestern people have a fairly large household size and this might be attributed to the dominance of charcoal production in the zone which influences the respondents to have more members in their household to shoulder the responsibility of charcoal production labour. Bada *et al.* (2009) in a related study reveal that most charcoal producers have household size of between 6 and 10 which has positive implications on the family labour availability for charcoal production which increase their production.

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

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

Bada et al. (2009), who reported that charcoal producers in Southwestern Nigeria typically have between 5 and 19 years of experience.

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

Variables	**Frequency**	**Percentage**	**Mean**
Age (Years)			39yrs
< 25	25	6.56	
25 – 35	68	17.84	
36 – 45	246	64.57	
> 55	42	11.02	
Sex			
Male	308	80.83	
Female	73	19.16	
Marital Status			
Married	256	67.19	
Single	101	26.50	
Divorced	14	3.67	
Widowed/Separated	10	2.62	
Years spent in school			11yrs
0	48	12.60	
1 – 6	123	32.28	
7 – 12	203	12.60	
>12	7	1.84	
Household size			9
< 5	55	14.44	
5 – 10	178	46.72	
> 10	148	38.85	
Average annual income from charcoal production (N)			445,866.10
< 250,000	121	31.76	
250,001 – 500,000	157	41.21	
500,001 – 1,000,000	92	24.15	
> 1,000,000	11	2.85	
Years of experience in charcoal production			14yrs
< 5	12	3.15	
5 – 10	94	24.67	
11 – 15	145	38.06	
16 – 20	80	21.00	
> 20	50	13.12	
Total	**100**	**381**	

Methods used for charcoal production in the study area

The results presented in Table 2 indicate that the earthen mound method is the most commonly used technique among charcoal producers, with 84.25% of respondents reporting its use. Additionally, 53.80% utilized the pit method, 44.09% employed the

mud kiln method, while 33.86% adopted the metal kiln method. The findings highlight the predominance of the earthen mound method in Southwestern Nigeria. This is consistent with the study by Bada et al. (2009), which also identified the surface (earthen mound) method as the most widely practiced approach to charcoal production across various regions of Nigeria. The result was in conformity with Eniola, *et al.* (2018) that using earthen mound to produce charcoal is mostly commonly used method in Nigeria since it is very cheap to construct and easy to use.

Table 2: Methods used in charcoal production in the study area

Methods	**Used**		**Not used**	
	F	**%**	**F**	**%**
Earthen mound method	321	84.25	60	15.75
Pit Method	205	53.8	176	46.2
Metal Kiln Method	168	44.09	213	55.91
Mud kiln Method	129	33.86	252	66.14

Perceived hazards associated with charcoal production in southwestern, Nigeria. (n=381)

Result from Table 3 presents the perceived hazards associated with charcoal production in southwestern, Nigeria. The results from the table revealed the Weighted Mean Score (WMS) result which indicate that charcoal producers' experiences spinal cord disorderliness during charcoal production was ranked 1st with the (WMS = 4.87) and charcoal production result to respiratory diseases were ranked 2nd with (WMS = 4.80), while, charcoal production causes skin and respiratory tract irritation and infection was ranked 3rd with (WMS = 4.65). Charcoal production causes back and muscle pains was ranked 4th with (WMS = 4.36), it causes body wound was ranked 5th with (WMS = 4.16), it causes body irritation was ranked 6th with WMS of 4.09 while leads to cuts, crushes, and laceration of hands with (WMS = 3.99) was ranked 7th. However, charcoal production aids malaria ranked 8th with (WMS = 3.97), charcoal production causes dizziness was ranked 9th with (WMS = 3.89), charcoal production causes falling and slipping was ranked 10th with (WMS = 3.79). The results suggest that respondents have been experiencing adverse effects associated with hazards from charcoal production. Specifically, a significant number of producers perceived that charcoal production could potentially cause body irritation. This finding aligns with Eniola et al. (2018), who noted that during charcoal burning, workers are frequently exposed to prolonged inhalation of noxious gases resulting from the incomplete combustion of wood. Such exposure has

been linked to various respiratory symptoms, including coughing, sputum production, sneezing, shortness of breath (dyspnea), and, in severe cases, hemoptysis (coughing up blood). Also, Table 4 revealed the environmental hazards associated with charcoal, soil micro-organism is threatened because of charcoal production ranked 1st with Weighted Mean Score (WMS = 4.99), charcoal production reduces the level of crop production was ranked 2nd with (WMS = 4.89), charcoal production leads to deforestation was ranked 3rd with (WMS = 3.83) while , charcoal production reduces air (oxygen) availability in the environment was ranked 4th with (WMS = 4.56), charcoal production leads to high intensity of the sun in soil surface was ranked 5th with (WMS = 4.50) while having more stress on land improve the quality of air and water in the environment was ranked 6th (WMS = 4.08). Continuous engagement in charcoal production reduces available trees for future use was ranked 7th with (WMS = 4.01). Charcoal production changes the rainfall pattern of the area was ranked 8th with (WMS = 3.67), it reduces water availability in the environment was ranked 9th with (WMS = 3.57). This result implies that respondents have been feeling the negative effects of charcoal production on their environment. The result is in line with United Nation, (2009) that during charcoal production a lot of heat is generated over several days due to the high temperature attained. This heat destroys all plants at the kiln site, air pollution occurs, wildlife too is affected.

Table 3: Perceived hazards associated with charcoal production in southwestern, Nigeria. (n=381)

S/N	Statements on Perceived hazards on charcoal production	WMS	RANK
	Health hazards		
1	Charcoal producer experiences spinal cord disorderliness	4.87	1st
2	Charcoal production result to respiratory diseases	4.80	2nd
3	It cause skin and respiratory tract irritation and infection	4..65	3rd
4	Back and muscle pains is associated to charcoal production	4.36	4th
5	Charcoal production cause body wound	4.16	5th
6	Charcoal production cause body irritation	4.09	6th
7	It lead to cut, crush and laceration of hand	3.99	7th
8	It aids malaria attack	3.97	8th
9	Charcoal producers experience dizziness	3.89	9th
10	Falling and slipping are common to charcoal producers	3.79	10th
	Environmental hazards		
11	Soil micro-organism is threatened because of charcoal production	4.99	1st
12	Charcoal production reduces the level of crop production.	4.89	2nd
13	Charcoal production lead to deforestation.	4.83	3rd
14	It reduced air (Oxygen) availability in the environment	4.56	4th
15	It leads to high intensity of the sun on soil surface.	4.50	5th

16	Having more trees on land improve the quality of air and water in the environment.	4.08	6th
17	Continuous engagement in charcoal production reduces the available tree for future use.	4.01	7th
18	Charcoal production change rainfall pattern of the area.	3.67	8th
19	It reduces water availability in the environment.	3.57	9th
20	Charcoal production could increase organic matter in the soil.	3.51	10th

WMS- Weighted Mean Score

Categorization of Perceived health hazards associated with charcoal production in Southwestern Nigeria. (n=381)

Table 4 revealed the perceived hazards of the respondents associated to charcoal production in the study area. It shows the distribution of the respondents into three categories (High, moderate and low) hazard using their weighted mean score. The results revealed that 70.34% of the respondents moderately perceived hazards associated to charcoal production while 16.54% of the respondents have a high level of perception of hazards toward charcoal production and 13.12% of the respondents have low perception of hazards associated with charcoal production.

This implies that majority of the respondents' experience several hazards such as spinal cord disorderliness, respiratory disease, body irritation, headache and chest pain relating to charcoal production, land degradation, Soil fertility, flooding among others but were minimal and not severe. Eniola *et al.* (2018) also inferred that charcoal production attracts various hazards on producers and environment which could be kept minimal, if proper mitigation options were adopted.

Table 4: Categorization of perceived hazards associated with charcoal production in the study area (n = 381)

Perceived health hazards on charcoal production	**Range**	**Frequency**	**Percentage**
High	29.7 - 45.3	63	16.54
Moderate	19.6 - 29.6	268	70.34
Low	1.1 - 19.5	50	13.12
Total		381	100.0
Standard Deviation	1.39		
Mean	24.1		

Minimum score = 1.1 Maximum score = 45.3

Methods used to manage hazards associated with charcoal production in the study area. (n=381)

Table 5 presents the methods used to manage hazards associated with charcoal production. The results reveal that wearing of glove during charcoal production was

ranked 1st with (WMS = 4.54), replanting of trees used for charcoal production was ranked 2nd with (WMS = 4.05), reduction in time of visit to charcoal kiln during production was ranked 3rd with (WMS = 3.75), also employment of paid labour to carry out tedious work during charcoal production was ranked 4th with (WMS = 3.74), while wearing of boots during charcoal production was ranked 5th with (WMS = 3.52). However, regular visitation to health care centers by charcoal producers, putting in breathing filter/nose mask during charcoal production and regular medical checkup by producers were ranked 6th with (WMS = 3.52), I take bath regularly after each day job was ranked 7th with (WMS = 3.34), siting of charcoal production site far away from residential area was ranked 8th with (WMS = 3.25), preventing under age children from the use of charcoal for cooking was ranked 9th with (WMS = 3.24), establishment of tree plantation mainly for charcoal production and fuel wood and public awareness of the hazards associated with charcoal production through appropriate campaign by government were jointly ranked 10th with (WMS = 3.18), government regulation on charcoal production was ranked least of 12th with (WMS = 3.13) while putting on breathing filter/nose mask during charcoal production was ranked last with (WMS = 2.87).

The result implies that respondents are not taking cognizance of the methods used to manage hazards associated with charcoal production and this might be due to non-availability and unaffordability in the study area, The results is in line with the findings of Eniola *et al.* (2018) which reveal that methods used to manage hazards associated with charcoal production were known to charcoal producers but due to the nonchalant attitudes and literacy level of the charcoal producers they don't take proper attention to this methods during charcoal production.

Table 5: Methods used to manage hazards associated with charcoal production in the study area. (n=381)

S/N	Methods used to manage hazard associated with charcoal production	WMS	RANK
1	Wearing of gloves during charcoal production.	4.54	1st
2	Replanting of tree used for charcoal production.	4.05	2nd
3	Reduction in time of visit to charcoal kiln during production.	3.75	3rd
4	Employment of paid labour to carry out tedious work.	3.74	4th
5	Wearing of boots during production.	3.54	5th
6	Regular visitation to health care centres by charcoal producers.	3.52	6th
7	I take bath regularly after each day job.	3.34	7th
8	Sitting of charcoal production site far away from residential	3.25	8th

9	Preventing under-age children from the use of charcoal for cooking	3.24	9th
10	Establishment of tree plantation mainly for charcoal production and fuel wood	3.18	10th
11	Public awareness of the hazard associated with charcoal production through appropriate campaign by government.	3.18	10th
12	Government regulations on charcoal production.	3.13	12th
13	Putting on breathing filter/nose mask during charcoal production	2.87	13th

WMS- Weighted Mean Score

Test of hypotheses of the study

The hypotheses of the study were tested and results presented below. It is to be noted that all the hypotheses were stated in null form.

$H0_1$: There is no significant relationship between selected socio-economic characteristics of the charcoal producers and perceived hazards associated with charcoal production. (n=381)

Table 6 presents the results of the analysis examining the relationship between the socio-economic characteristics (age, income from primary occupation, years of formal education, years of experience in charcoal production, and household size) of the respondents and the perceived hazards associated with charcoal production. Pearson Product Moment Correlation (PPMC) analysis revealed significant relationships between these variables and perceived hazards. Specifically, age ($r = 0.439$, $p < 0.05$), years of formal education ($r = 0.392$, $p < 0.05$), income from primary occupation ($r = 0.237$, $p < 0.05$), household size ($r = 0.280$, $p < 0.05$), and years of experience in charcoal production ($r = 0.237$, $p < 0.05$) were all significantly associated with perceived hazards in the study area. However, all significant variables, except for age, exerted a negative influence on the perceived hazards, indicating that as these factors increase, the perception of hazards associated with charcoal production decreases. As a result, the null hypothesis was rejected. This finding supports the work of Kato et al. (2005) and Ellegard (1994), who observed that while charcoal production poses health hazards, higher levels of education, income, and experience can mitigate these hazards and improve production efficiency.

Table 6: Significant Relationships Between Socio-Economic Characteristics and Perceived Hazards in Charcoal Production (n=381)

Socio-economic characteristics	**r-value**	**p-value**	**Remark**
Age	0.439	0.050	S
Years of formal education	-0.392	0.012	S
Income from Occupation	-0.410	0.021	S
Year of Experience in Charcoal Production	-0.237	0.041	S
Household size	-0.280	0.046	S

Significant level: $p < 0.05$, S = significant; NS = not significant

There is no significant relationship between methods used in charcoal production and the perceived hazards associated with charcoal production in the study area (n=381)

Table 7 presents the results of the test for a significant relationship between the methods used in charcoal production (Earthen mound method, pit method, metal kiln, mud kiln, and traditional method) and the perceived hazards associated with charcoal production. The Chi-Square analysis revealed a significant association between the Earthen mound method ($\chi 2 = 52.13$, $p < 0.05$) and the Pit method ($\chi 2 = 62.90$, $p < 0.05$) and the perceived hazards in the study area. Consequently, the null hypothesis is rejected for both the earthen mound and pit methods. This indicates that these two methods were the most prevalent in the study area. These findings align with those of Bada et al. (2009), who reported that the earthen mound and pit methods are among the most commonly used methods of charcoal production in various regions of Nigeria.

Table 7: Summary of chi-square test establishing relationship between methods used in charcoal production and perceived hazards associated with charcoal production (n=381)

Socioeconomic characteristics	**χ^2-value**	**Df**	**p-value**	**Remark**
Earthen Mound method	52.13	23	0.015	S
Pit method	62.90	21	0.005	S

Significance level: $p < 0.05$
S = significant

Conclusion and recommendations

The following conclusion were drawn from the study

1. Demographic Characteristics: The majority of the respondents were male and married, with an average age of 39 years. Charcoal production was the primary

occupation of respondents, who had an average of 14 years of experience in the field.

2. Predominant Production Method: The earthen mound method was the most commonly used technique for charcoal production in the study area.
3. Production Activities: Charcoal producers were deeply involved in various stages of the production process, including site selection for kiln construction, tree felling, cross-cutting of trees into logs, kiln insulation with grass and soil, sorting, storing, and packaging of charcoal.
4. Health Implications: Due to the physically demanding nature of charcoal production, there are growing concerns that the health of producers could deteriorate if they continue to use traditional methods.
5. Hazard Management: Methods for managing the hazards associated with charcoal production, such as wearing gloves, boots, and regular visits to health care centers, were found to be neither affordable nor easily accessible to producers in the study area.

Therefore, the following recommendations were formulated from the study:

1. Community Involvement in Forest Management: It is recommended that community leaders and stakeholders actively engage in forest management efforts, including voluntary patrolling of production sites, to prevent the indiscriminate felling of trees for charcoal production.
2. Promotion of Alternative Livelihoods: Environmentally friendly alternative livelihood activities, such as beekeeping, fish farming, snail farming, and vegetable production, should be promoted among rural communities to reduce their dependence on charcoal production.
3. Health and Environmental Awareness Campaigns: To address the negative health and environmental impacts of charcoal production, awareness campaigns should be launched to educate rural dwellers about the risks and consequences of the practice.
4. Regulated Charcoal Production: Although a complete ban on charcoal production is unlikely to be effective, clear guidelines and regulations should be established to ensure that charcoal production is carried out in a safer and more sustainable manner, minimizing its harmful health effects.

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