

ASSESSMENT OF CHARCOAL PRODUCTION IN MORO LOCAL GOVERNMENT AREA OF KWARA STATE, NIGERIA

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ABSTRACT

This study examined charcoal production in the Moro Local Government Area. Four communities (Asumo, Korede, Abuilide, and Jebba) were selected based on the information gathered from the Charcoal Dealers Association in the State. Twenty-five questionnaires were administered in each community. The data obtained were analyzed using

Introduction

The increase in population and industrialization in some developing countries has resulted in scarcity in the supply of indigenous tree biomass and fuel. Tree biomass is the major source fuel wood in rural communities. About 13% of the world primary energy is obtained from the forest. People in the developing countries of the world derived at least 90% of their energy requirement from wood and charcoal (Fuwape and Akindele 1997). A large proportion of forest resources have been destroyed through excessive exploitation of the forest for timber, pulp, fire wood and charcoal. Fuwape (2001) and Klasnja *et al.*, (2002) asserted that there is no feasible alternative to wood as an energy source in some of the underdeveloped and developing countries in Africa



descriptive and inferential statistics. The results revealed that among 402 tree species identified for the production of charcoal in the study area, *Anogeissus leiocarpus* had the highest percentage of 16.10 followed by *Detarium microcarpum* (8.90%) and *Diospyros mespiliformis* (7.90%). The results of the chi-square analysis further revealed there is a significant relationship between the secondary occupation of the respondents and the reasons for charcoal production/business, there is also a significant relationship between the education level and primary occupation of the respondents with the choice of tree species not used for charcoal production at 0.05 level of significance. Since most of the producers depend on either community forests and/or marginal land as their source of wood, it is therefore recommended that charcoal producers through their association and other stakeholders invest in private woodlot plantations to ensure the sustainability of the business as other alternative sources of fuel are too expensive, especially for the lower and middle-class household in the area.

Keywords: Charcoal; Fuel Wood; Tree Species; Savanna

and Asia. The central role of fuel wood in domestic energy budget is mostly due to socio-economic reasons, which include low income, large family size, high cost of alternative source of energy etc. The solution to fuel wood crises in some countries in Africa, Asia and Latin America lies in afforestation and reforestation (Tella and Fuwape, 2005).

The accurate estimation of forest biomass is crucial for many applications, from the commercial use of wood to the global carbon cycle (Gibbs *et al.*, 2007). Tunde *et al.*, (2013) reported that almost all charcoal are produced in rural areas, especially in forested and marginal land/free areas and it contributes greatly to the deterioration of the environment resulting in an increase of carbon-dioxide in the atmosphere. The growing demand for charcoal has resulted in deforestation in vulnerable areas (Salau and Keshinro, 2015). To improve the availability of wood and reduce deforestation due to over-exploitation of forest especially in rural and semi-urban areas, there is a need to identify the common tree species used, the method of harvesting, and the size of the wood being harvested. The main

objectives of this study were to identify common tree species used for charcoal production, to assess the demographic characteristics of charcoal producers, and to examine the major reasons for charcoal production in the study area.

Materials and Methods

Study area

This study was conducted in four (4) communities of Moro Local Government Area of Kwara State (Figure 1). Moro is situated between latitudes $8^{\circ}20'N$ and $8^{\circ}50'N$ and Longitudes $4^{\circ}25'E$ and $4^{\circ}65'E$ with a tropical wet and dry climate and average yearly rainfall of about 1200 mm (Salau and Keshinro, 2015). Its mean annual temperature is about $26.2^{\circ}C$; which peaks at about $30^{\circ}C$ in the month of March and about 45% humidity. The wet season is generally experienced between April and October and dry season between November and March. April is the warmest month and December has the lowest average temperature of about $22.5^{\circ}C$ with an average of 264 mm.

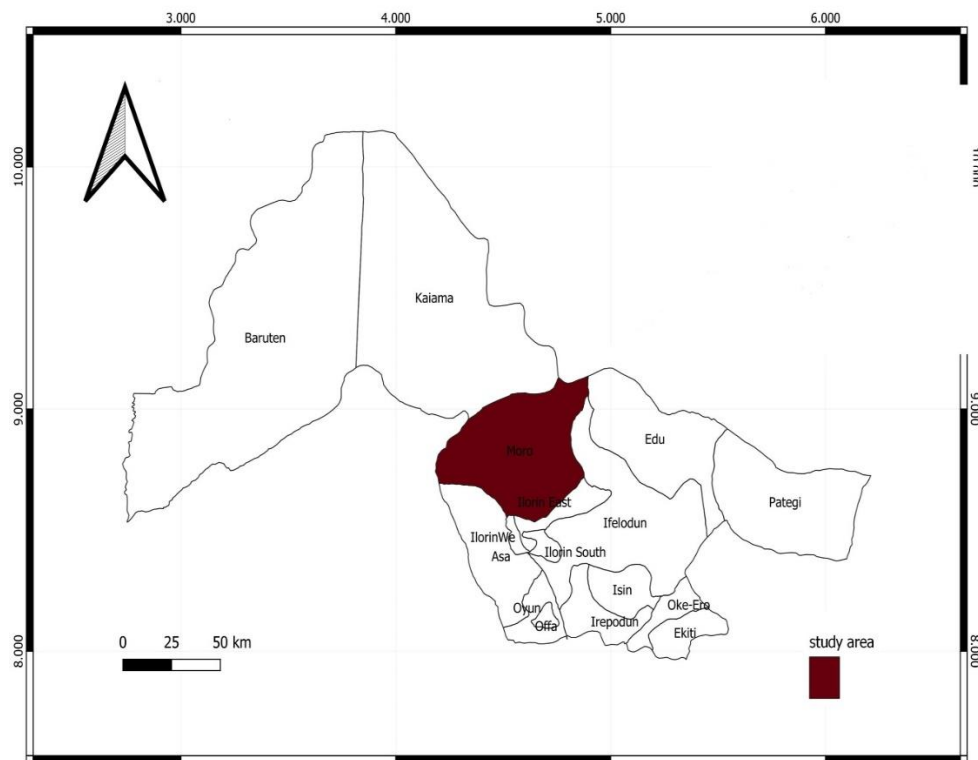


Figure 1: Map of Kwara State showing Moro LGA (Study Area)



Method of data collection

Questionnaire design

A reconnaissance visit was conducted in the study area to familiarize and interact with the charcoal producers. Questionnaires were developed to assess information about the tree species used for charcoal production in the study area. Four communities (Asumo, Korede, Abuilide and Jebba) were selected and twenty-five (25) questionnaires were administered in each community. The respondents were selected through the Charcoal Dealers Association in the State. The questionnaire was both open and closed-ended and administered by both face-to-face and paper and pencil methods.

Data analysis

Descriptive and inferential statistics (chi-square) were used to summarize and analyze the data obtained from the respondents. The demographic characteristics of the respondents, tree species used as well as those not used for charcoal production, dbh and height classes of tree species, reason for charcoal production as well as sources of wood raw materials and part of the trees used for charcoal production were also assessed.

Results

Demographic characteristics of the charcoal producers

The demographic characteristics (Table 1) of the respondents revealed that out of 100 interviewed, 88 were males while only 12 were females. The majority of charcoal producers in the study area fall within the age groups of 20 – 40 and 41 – 60 years. Business and farming formed the major primary (45 % and 53 %) and secondary occupation (43% and 43%) of the charcoal producers respectively. The educational status of the respondents revealed that 37 respondents had primary education, while only 32 had secondary education and only 7 attained tertiary educations. About 35 % of the respondents spent up to 6-10 years in the charcoal business followed by 11-10 years with 21 % experience in the business and only 10 % had more than 20 years' experience in the business.



Table 1: Distribution based on the Demographic characteristics of the respondents

Variable	Class	Freq. of mention	Percentage
Gender	Male	88	88.0
	Female	12	12.0
Age group of the respondents			
	< 20 years	2	2.0
	20 - 40 years	47	47.0
	41 - 60 years	49	49.0
	over 60 years	2	2.0
Education status of the respondents			
	No formal educ.	24	24.0
	Primary	37	37.0
	Secondary	32	32.0
	Tertiary	7	7.0
Primary occupation of the respondents			
	Farming	45	45.0
	Business	53	53.0
	Student	2	2.0
Secondary occupation of the respondents			
	Farming	43	43.0
	Business	43	43.0
	Others	14	14.0
Years of experience			



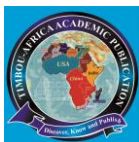
	1-5	17	17.0
	6-10	35	35.0
	11-15	21	21.0
	16-20	19	19.0
	>20	8	8.0

Tree species used for charcoal production

The respondents mentioned 402 trees distributed among 29 species and 13 families using the questionnaire in the study sites (Table 2). Among the tree species identified *Anogeissus leiocarpus* was the most dominant tree species, found in all the communities with 65 stands (16.2%) followed by *Detarium microcarpum* which was also evenly distributed among the communities with 47 stands (11.7%), then followed by *Diospyros mespiliformis* with 32 stands (8.0%). Most of the tree species are site specific with fewer stands (< 20) but they are of great importance for charcoal production.

Table 2: Tree species used for charcoal production

Family	Tree species	Freq. of mention	Percentage
Anacardiaceae	<i>Lannea microcarpa</i>	12	3.0%
Chrysobalanaceae	<i>Parinari macrophylla</i>	5	1.2%
Combretaceae	<i>Anogeissus leiocarpus</i>	65	16.2%
	<i>Combretum nigricans</i>	9	2.2%
	<i>Guiera senegalensis</i>	9	2.2%
Ebenaceae	<i>Diospyros mespiliformis</i>	32	8.0%
Fabaceae	<i>Acacia albida</i>	7	1.7%
	<i>Acacia nilotica</i>	6	1.5%
	<i>Albizia chevalieri</i>	3	0.7%
	<i>Albizia lebbek</i>	1	0.2%
	<i>Andira inermis</i>	2	0.5%



	<i>Burkea Africana</i>	17	4.2%
	<i>Daniellia oliveri</i>	9	2.2%
	<i>Detarium macrocarpum</i>	47	11.7%
	<i>Entada Africana</i>	15	3.7%
	<i>Isoberlinia doka</i>	14	3.5%
	<i>Parkia biglobosa</i>	5	1.2%
	<i>Piliostigma reticulatum</i>	9	2.2%
	<i>Prosopis africana</i>	21	5.2%
	<i>Pteracarpus erinaceus</i>	23	5.7%
	<i>Tamarindus indica</i>	5	1.2%
Lamiaceae	<i>Vitex doniana</i>	2	0.5%
Meliaceae	<i>Azadirachta indica</i>	17	4.2%
Moraceae	<i>Ficus trichopoda</i>	9	2.2%
Myrtaceae	<i>Syzygium guineense</i>	21	5.2%
Rhamnaceae	<i>Ziziphus spina-christi</i>	12	3.0%
Sapotaceae	<i>Vitellaria paradoxa</i>	9	2.2%
Ulmaceae	<i>Celtis integrifolia</i>	6	1.5%
Zygophyllaceae	<i>Balanites aegyptiaca</i>	10	2.5%
Total		402	100.0%

Tree species not used for charcoal production

The results of the tree species not used for charcoal production mentioned by the respondents is displaced in Table 3. There are about 261 tree species distributed in 15 species and 8 families. *Parkia biglobosa* had the highest frequency of mention of 52 (19.9 %) followed by *Vitellaria paradoxa* with 32 stands (12.3 %), *Borassus aethiopium* with 31 stands (11.9 %) and *Gmelina arborea* with 30 stands (8.0 %). While the species with the least frequency of mentioned include *Daniellia oliveri*, *Elaeis guineensis* and *Mangifera indica* each 1.1 %.



Table 3: Tree species not used for charcoal production

Family	Tree species	Freq. of mention	Percentage
	<i>Adansonia digitata</i>	23	8.8%
	<i>Andira inermis</i>	10	3.8%
	<i>Borassus aethiopium</i>	31	11.9%
	<i>Ceiba pentandra</i>	10	3.8%
	<i>Cissus populnea</i>	9	3.4%
	<i>Daniellia oliveri</i>	3	1.1%
	<i>Elaeis guineensis</i>	3	1.1%
	<i>Ficus capensis</i>	4	1.5%
	<i>Gmelina arborea</i>	30	11.5%
	<i>Hyphaene thebaica</i>	20	7.7%
	<i>Mangifera indica</i>	3	1.1%
	<i>Parkia biglobosa</i>	52	19.9%
	<i>Sterculia setigera</i>	10	3.8%
	<i>Tectona grandis</i>	21	8.0%
	<i>Vitellaria paradoxa</i>	32	12.3%
	Total	261	100.0%

Charcoal production and sources of wood raw materials

The results for the reasons why respondents were into charcoal production revealed that about 66 % of the respondents considered charcoal production as a “Business” and about 23 % of the respondents referred it as “To augment income” (Table 4). The results of sources of wood raw materials revealed that 93 % of the respondents sourced the wood from the community forest and/or marginal land whereas only 7 % of the respondents sourced the wood from both free area and reserve area (Table 5). The part of the tree/plant used for the charcoal production shows that 37 % of the respondents used “Felled tree stems and branches”, 25 % “Shrub and branches” and 23 % uses “All” to produce the charcoal from the tree. The diameter and height distribution of the trees used for charcoal production showed that about 58 % of the tree species used for the charcoal production have a diameter of 26 – 35 cm whereas only 27 % of trees had a diameter of more than 35 cm and the “6 – 10 m” height of the tree species recorded the



highest percentage of 49.2 % and only 5.0 % had a height of “>10 m” (Table 6).

Table 4: Responses of charcoal producers on the “Why are you into charcoal production?”

	Frequency	Percentage (%)
Business	66	66.0
Lack of employment	6	6.0
To augment income	23	23.0
To earn living	5	5.0
Total	100	100.0

Table 5: Source of wood raw materials and part of plant used for charcoal production

	Frequency	Percentage (%)
Sources of wood raw materials		
Community forest and marginal land	93	93
Free area and Reserve area	7	7
Part of plant used		
Felled tree stems	6	6
Branches	6	6
Felled tree stems and shrubs	3	3
Felled tree stems and Branches	37	37
Shrubs and branches	25	25
All	23	23

Table 6: Diameter and height distribution of the tree species used for charcoal production

Variable	Class	Freq.	Percentage (%)
Diameter (cm)	5 - 15	3	2.5
	16 - 25	14	11.7
	26 - 35	70	58.3
	> 35	33	27.5



Length (m)	<1	17	14.2
	1 - 5	38	31.7
	6 - 10	59	49.2
	>10	6	5.0

Results of the Chi-Square Analyses of Socio-economic characteristics of Charcoal Producers on the Reasons for charcoal, Species used and Species not used for charcoal production

The results of the Chi-square analysis in Table 7 showed that there is a significant relationship between Secondary occupation ($\chi^2 = 16.549$, $df = 6$, $p < 0.05$) and “Why are you into charcoal production?” The relationship between the Educational level ($\chi^2 = 65.756$, $df = 45$, $p < 0.05$) and “Species not used for charcoal production” is also significant. There is also a significant relationship between Primary occupation ($\chi^2 = 49.150$, $df = 30$, $p < 0.05$). All other Socio-economics characteristics were not significance with all the parameters tested at $\alpha = 0.05$.

Table 7: Chi-square analysis of socio-economic characteristics and Reasons for charcoal business, Species used and Species not used for charcoal production

Variable	χ^2	Df	P-value	Decision
Why are you into charcoal production?				
Gender	4.136	3	0.247	Not significant
Age group	8.702	9	0.465	Not significant
Education level	5.501	9	0.789	Not significant
Primary occupation	11.961	6	0.063	Not significant
Secondary occupation	16.549	6	0.011	Significant
Years of Experience	11.360	12	0.498	Not significant
Species used for charcoal				
Gender	29.577	29	0.435	Not significant
Age group	80.086	87	0.687	Not significant
Education level	101.017	87	0.144	Not significant
Primary occupation	64.955	58	0.247	Not significant
Secondary occupation	63.092	58	0.301	Not significant



Years of Experience	137.278	116	0.086	Not significant
Species not used for charcoal				
Gender	13.107	15	0.594	Not significant
Age group	40.737	45	0.653	Not significant
Education level	65.756	45	0.023	Significant
Primary occupation	49.150	30	0.015	Significant
Secondary occupation	42.733	30	0.062	Not significant
Years of Experience	76.804	60	0.071	Not significant

DISCUSSION

Demographic characteristics of charcoal producers

The demographic characteristics of the respondents were presented in Table 1. The result shows that there were more males (88) than females (12) in the charcoal business, this is not disconnected with the rigorous activity involved in charcoal production. The age group of the respondents falls between 20 – 40 and 40 - 60 age groups; this denotes that respondents within this group suite the enterprise because of the energy exertion required during charcoal production. The study also revealed that majority of the respondents had Primary education (37 %) and Secondary education (32 %) and only few with Tertiary education (7 %), which implies the low level of education in the study area. The Business and Farming are the two major Primary (53 and 45) and Secondary (43 and 43) occupations respectively. This result supports that of Adejumobi and Eniola (2011) findings about charcoal producers in Oke-Ogun, that their level of education is low. The finding is also similar to what Adeniji *et al.* (2015) reported, that the active age group for charcoal production in Niger State was 20-39 years. Adebayo *et al.* (2019) reported a similar result in Saki West and Ibarapa North Local Government Areas of Oyo state, that 57.5% of the respondents were Male, 32.5% were within the Age group of 40-49 years, while 45.0% and 42.5% had Primary and Secondary school education, respectively. Also, 32.5 % of the respondents had 16 - 20 years' experience in charcoal production.

Tree species used and not used for charcoal production

The results of the analysis showed that *Anogeissus leiocarpus* is the commonest species used for charcoal production across in the study area followed by *Detarium microcarpum*, *Diospyros mespiliformis*, and



Pterocarpus erinaceus (Table 1). This is because apart from being the most diverse tree species in the area they also produce charcoal with high calorific value. Adebayo et al. (2019), reported similar results in the similar study area of this research (Saki West and Ibarapa North of Oyo State) where *Anogeissus leiocarpus* had (77.5% and 66.3%), followed by *Vitellaria paradoxa* (68.8%, 85.0%), *Bridelia ferruginea* (58.8%, 65.0%) and *Terminalia spp* (41.3%, 56.3) in the two locations. The respondents prefer these trees because of the uniqueness of good quality charcoal produced by them. Izekor & Modugu (2011) reported a similar results that tree species such as *Anogeissus leiocarpus*, *Bridelia ferruginea*, *Terminalia spp*, and *Pericopsis laxiflora* produces dense charcoal with higher calorific value.

Majority of the respondents listed some tree species that are not used for charcoal production in the study area which includes *Parkia biglobosa*, *Vitellaria paradoxa*, *Borassus aethiopicum* and *Gmelina arborea*. This shows the economic value of the products obtained from these species especially in the rural areas. The timber obtained from *Gmelina* and other Non-Timber Forest Products (NTFPs) obtained from Locust beans and Shear butter trees contributed significantly to the economic development in the area. This study also corresponded with Tunde et al. (2013), that reported trees such as Axle wood (*Anogeissus leiocarpus*), *Burkea* (*Burkea africana*), Shea butter (*Vitellaria paradoxa*) have dense wood that produces good quality charcoal. The results of this research also align with the Netherlands Programmes Sustainable Biomass study, which shows that charcoal producers prefer tree species with slow-burning features for charcoal, however, these tree species are important economic trees and therefore vulnerable to over-exploitation (BTG, 2020).

Charcoal production and sources of wood raw materials

About 66 % of the respondents considered charcoal production as a “Business” and about 23 % of the respondents referred to it as an alternative source to their income “To augment income”. 93 % of the respondents sourced the wood from the free area whereas only 7 % sourced the wood from both the free area and the reserve area. Most of the charcoal producers use the entire tree stem and branches to make charcoal, and only a few make use of the branches alone to make the charcoal (6 %). The

diameter and height distribution of the trees used for charcoal production in the study area showed that more than 58 % of the tree species used for charcoal production have a diameter of about 26 – 35 cm with a height in the range of “6 – 10 m”. This shows the typical nature of tree species in the savanna area with a medium diameter and moderate height, only a few stands grow beyond 10 m in height.

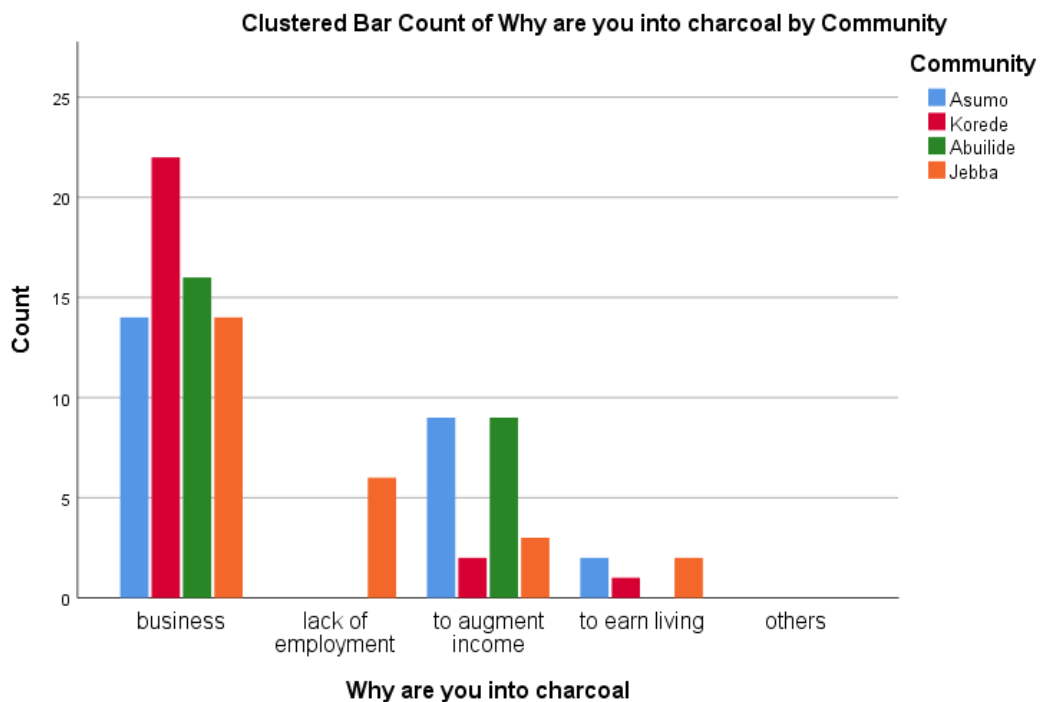


Figure 2: Distribution of the respondents on purposes of charcoal production in the study area

Results of the Chi-Square Analyses of Socio-economic characteristics of Charcoal Producers on the Reasons for charcoal, Species used and Species not used for charcoal production

The results of the chi square analysis showed that there is a significant relationship between Secondary occupation ($\chi^2 = 16.549$, $df = 6$, $p < 0.05$) and “Why are you into charcoal production?” The choices/reasons of the respondents for being into charcoal production depends on their secondary occupation, this means that more than 43 % of the respondents regarded charcoal production as their alternative source of income whereas another 43 % regarded farming as their secondary source of income. The



choice/reason for charcoal production is therefore influenced by the secondary occupation of the respondents. The relationship between the Educational level ($\chi^2 = 65.756$, $df = 45$, $p < 0.05$) and “Species not used for charcoal production” is also significant. There is also a significant relationship between Primary occupation and “Species not used for charcoal production” ($\chi^2 = 49.150$, $df = 30$, $p < 0.05$). The level of education of the respondents also determine the type of tree species not to be used for the charcoal production especially when the tree species is considered to be of economic value in the area. The higher the level of education the more some valuable species are excluded for harvest to make charcoal in the area. Adebayo *et al.* (2019) reported that since the charcoal producers' level of education is low, it will affect their knowledge of the effect of charcoal production on the environment. This indicates that an increase in the educational level of the respondents will improve their perception of the effect of charcoal production on deforestation. This results also agrees with that of Tunde *et al.*, (2013) and Jelili *et al.*, (2015) that charcoal producers' low level of education harms forest sustainability.

Conclusion and Recommendation

There is a vast number of tree species in the savanna that are suitable for the charcoal production, however the method of harvesting is crude and wasteful. The whole tree species would be harvested instead of cutting down the branches especially the savanna tree species where the size of branches of some tree species is equivalent or even higher than the tree stem. The charcoal makers cut down the entire tree in order to maximize the profit thereby depleting the scarce resources of wood materials which often lead to deforestation and land degradation. It's therefore recommend that the charcoal producers should focused more on the tree branches rather than cutting the entire stem to make charcoal, since most of the savanna tree species have big branches that are capable of producing charcoal equivalent or even higher than that of stem/bole. There should also be more emphasis on establishing private woodlot rather than over dependence on the government and community forests to ensure the sustainability of the business as other alternative sources of fuel are too expensive, especially for the lower and middle-class household in the area.



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