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Assessment of human activities and its effects on forest management: a survey of charcoal producers in the Sekyere Central District of Ghana

John Bokaligidi Lambon^{1,*}, Joseph Okani Honger² and David Yakubu Anambam³

¹ Council for Scientific and Industrial Research, CSIR-Head Office, Accra, Ghana

² Soil and Irrigation Research Centre, School of Agriculture, College of Basic and Applied Sciences, University of Ghana, Legon, Accra, Ghana

³ Department of Agriculture, Ejisu Municipal Assembly, Kumasi, Ghana

* Author to whom any correspondence should be addressed.

E-mail: jlambon2000@yahoo.com, johonger@yahoo.com and danambam@yahoo.com

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Supplementary material for this article is available [online](#)

Abstract

A survey to assess the effects and sustainability of charcoal production on the local vegetation cover was conducted in the Sekyere Central District of Ashanti region from December 2017 to April 2018. The study involved the use of structured questionnaires, focus group discussions (FGDs), key informants, secondary data and field observation by reconnaissance survey. The socio-economic survey was to identify who in the district is undertaking charcoal production as an economic venture, how widespread the activity is, and the preferred tree species being harvested to produce charcoal. In the field survey, the vegetation types in the study area were identified in a reconnaissance survey as secondary forests with increasing grassland. The relative abundance of tree species which could be used for charcoal production was also identified and quantified. A 640-meter square plot was delimited and divided into 64 square plots within each of which five-meter quadrats were marked at random and presence or absence was recorded for the individual tree species. The results of the study indicated that charcoal production is widely carried out throughout the district especially in the Afram Plains portion. It is practiced by the Akan and the Sissala ethnic groups who have very little education. Female producers (8%) were less than their male counterparts. Majority (73%) of the producers was 31 and above years while those of 30 years and below was 27%. The study revealed that most tree species are becoming rare and are only common in the protected area (Kogyae strict nature reserve) in the district.

1. Introduction

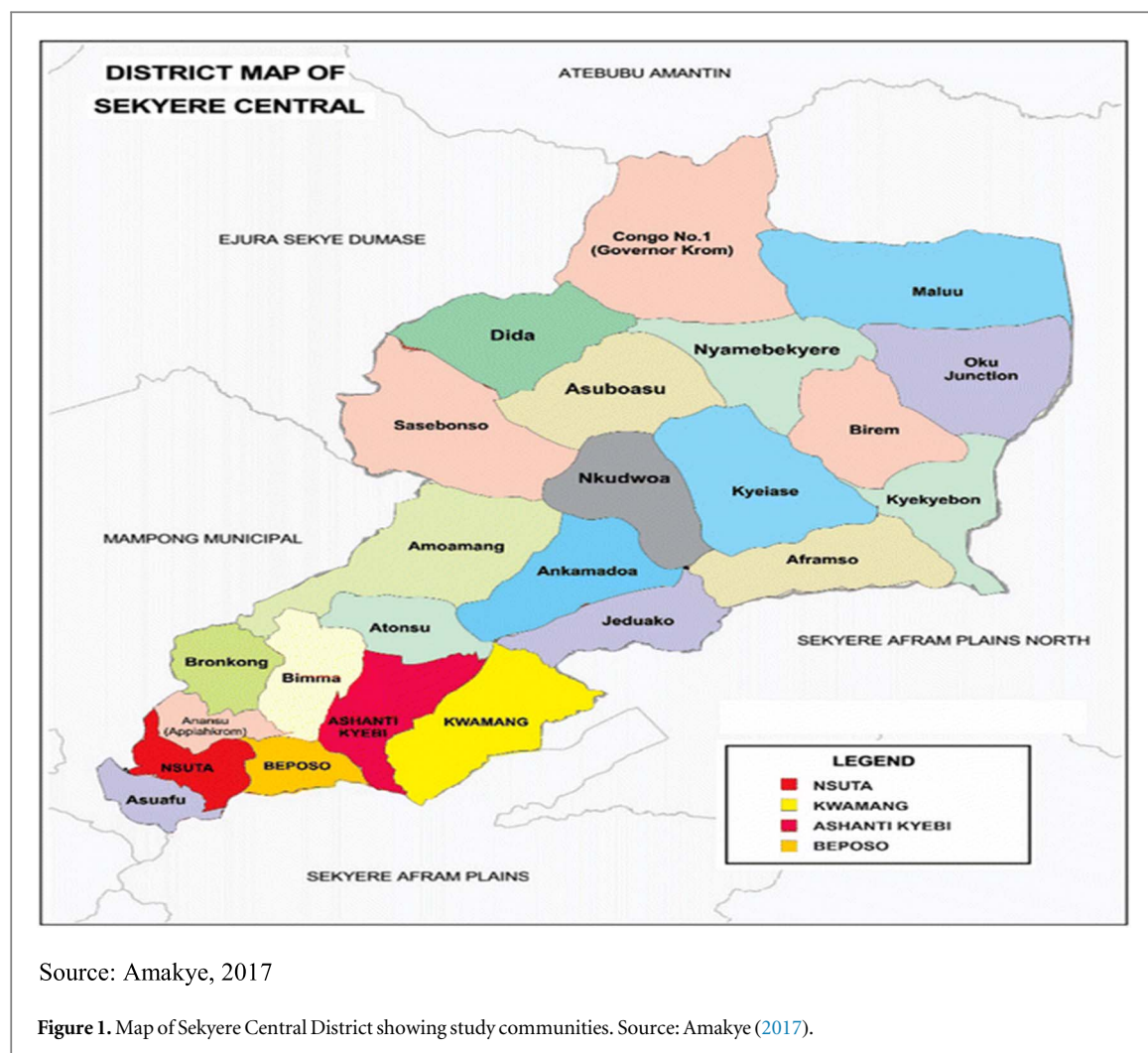
Forests in Ghana and elsewhere play a very important role in the sociocultural, economic and ecological aspects of life. The forests in Ghana are characterized by strong rainfall gradients in general with highest rainfall near the coast, declining inland towards the savannas. Even though Ghana has a successful reservation of the natural forests, a closer look reveals a more degraded forest resource. According to Antwi (1999), forest reservation started in the 1920s until the 1940s where 16% of the total land area of Ghana was set aside as forests (266 forest reserves, 18 terrestrial wildlife reserves and five coastal wetland/Ramsar sites) reserves. In the high forest zone alone 20%–25% of land is under reservation i.e., 1.7 million hectares of which 1.6 million hectares are under the control of the Forest Service Division and about 136,000 ha under the Wildlife Division of the Forestry Commission. Within the forest reserves are permanent protection areas that consist largely of hill sanctuaries, swamp sanctuaries, shelterbelts, special biological protection areas, provenances and fire protection areas.

The importance of forest resources in Ghana cannot be underestimated as they provide tangible goods and ecological services. The most easily quantifiable of these is the timber industry, which is a key component of the national economy. It accounts for 11% of total export earnings and 6% of Gross Domestic Product (GDP) and offers employment for over 1,000,000 people who provide livelihood for about 2,000,000 people (Appiah 1998). The forest also contributes to several aspects of rural life providing food, fodder, building materials and household items as well as many more intangible benefits such as cultural symbols, ritual artifacts and sacred sites. In addition, trade in Non-Timber Forest Products (NTFPs) is an important economic activity in all parts of the forest zone, involving a great number of people including gatherers, wholesalers and retail traders (Owusu *et al* 1998). The common NTFPs include fruits, snails, bushmeat, medicines, spices, chewing sticks, cola nuts, etc. Farms and fallow lands are secondary forests and are important sources of these NTFPs even when access to forest resources is good. The forest reserves are entered for rarer products such as medicines, canes and some building materials unavailable on fallow lands and on farms. At the moment there is no accurate data on the rate of exploitation of wildlife resources for both subsistence and commercial use. Owusu *et al* (1998) however indicated that the wildlife division estimated that game is the main source of meat protein for about 80% of the rural population.

Woodfuel (firewood and charcoal) consumption has also increased rapidly in the urban areas as a result of price hikes in Liquefied Petroleum Gas (LPG) and other forms of energy. The natural forest in Ghana is the main source of woodfuels. Earlier reports indicated that it accounted for over 75%–85% of the total energy consumed in Ghana years ago (Dwumfour 1993, Mensah and Agyare 1994, Owusu *et al* 1998). The Ghana statistical services in their Ghana living standard survey (GLSS7 2019) indicated that domestic charcoal consumption is 34.1%, firewood is 33.3% and LPG is 24.5%. It has been reported recently that firewood or charcoal are the main cooking fuel for 4.5 million households (HHs) and that woodfuels are also widely used for institutional and commercial catering, industrial processing, and small enterprises (Hooda *et al* 2022, World Bank 2022). The extraction of fuelwood and/or production of charcoal have positive socio-economic considerations in the country. The production, distribution and marketing of these products, provided jobs of over 55,000 people (Nketia 1992). As an off-farming season activity for full-time farmers, fuelwood provide an important supplementary source of income to farmers. It also provides quite a substantial but unspecified amount of revenue to the producing district assemblies.

Forest depletion has been on the increase over the last three decades. This is however not peculiar to Ghana's forest but to the tropical forest of the world leading to threat and loss of biodiversity. A study in Ethiopia however, found that adopting community-based forest management increased forest cover (Takahashi and Todo 2012). Records indicate that at the beginning of the last century, Ghana had about 88,000 km² of forest and by 1950, the area had been reduced to 42,000 km². Currently the closed forest is about 15,000 km². According to the FAO (2020) the annual deforestation rate in Ghana rose to 794,214 ha per annum and if the trend continues at same rate the forest would have gone by the year 2025. Charcoal production is alleged to be one of the activities in the country that contributes to the destruction of vegetative cover in Ghana. It's been established that about 80% of the charcoal produced in Ghana comes from the forest-savanna transitional areas like Kintampo, Nkoronza and Atebubu in the Bono East region, Ejura, Mampong, Effiduase in the Ashanti region and sometimes in the Eastern and Volta regions. The other 20% is mainly from the forest zone in the Western region and the coastal savanna (Nketia 1992, Mensah and Agyare 1994, Lurimuah 2011). Charcoal production is one of the rural non-agricultural activities that is growing rapidly in the rural areas (Obiri *et al* 2013, Brobbey *et al* 2015). Its marketing and consumption has increased in urban and peri-urban areas. About 500,000 metric tonnes of charcoal is said to be produced annually mainly from felling live trees in forest-savanna transitional zones (Obiri *et al* 2013, Brobbey *et al* 2015, Asante and Nketiah 2019). It is also estimated that over 55,000 people are involved in the industry in the areas of production, distribution and marketing of charcoal in Ghana and that over 85% of the rural poor and the urban low income earners depend on it as a major source of energy (Nketia *et al* 1988, Obiri *et al* 2013). The commercial production of charcoal in Ghana is by the traditional Earth mound method (Nketia *et al* 1988, Lurimuah 2011, Obiri *et al* 2013). Charcoal as a rural commodity is consumed in the District capitals and other peri-urban areas but the bulk of it is sent to major marketing centers such as Kumasi, Obuasi, Tarkwa, Cape Coast, Accra and Takoradi. With the increase in the prices of the product due to the ever-increasing prices of crude oil in the international market, coupled with rising unemployment of the youth and poor agricultural outputs and prices in the rural areas, many people are venturing into the industry with its attendant problems for the forests.

The objectives of the study are to determine the specific group of people who undertake charcoal production as an economic venture in the Sekyere Central district, determine how widespread it is in the Sekyere Central district, determine if there are preferred tree species for the industry in the Sekyere Central district, and determine the extent it causes to tree species loss in the Sekyere Central District.



2. Materials and methods

2.1. Description of study area

The Sekyere Central District Assembly was created by a Legislative Instrument (LI) 1992 in 2008 from the then Sekyere West District as a result of the high growing population and the need to spread development to other parts of the District. The District is one of the forty-three (43) administrative districts in the Ashanti Region of Ghana with Nsuta as its capital. It is located at the northern part of the region, and shares boundaries with Mampong Municipal, Atebubu-Amanten District, Sekyere East, Sekyere South, and Ejura-Sekyeredumasi (figure 1). According to the (GSS 2014), the land size of the District is 1,631 km² and located within longitudes 0.05 degrees and 1.30 degrees west and latitudes 6.55 degrees and 7.30 degrees north (figure 1). With about 150 settlements, seventy (70) percent is rural in the Afram Plains portion of the district where some communities have less than 50 people. The District has bimodal rainfall pattern with an average annual rainfall of 1270 mm. The major rainy season starts in April, with a peak in May/June. There is a slight dip in July and a pick in August/September, tapering off in November. The dry season is from December to March where the weather becomes dry, hot, and dusty. The average temperature in the district is about 27 °C with variations in mean monthly temperature ranging between 22–30 °C throughout the year.

2.2. Selection of the communities and interviews

In all the five charcoal producing communities that were selected for the survey, all respondents were made to understand that the survey was for academic purposes and that information provided would be confidential which they agreed before the interview. These communities are Birem, Jeduako, Aframso, Kyeiase, and Kyekyebong all in the Afram plains portion of the district (figure 1). These communities were purposively selected due to the large volumes of charcoal produced there and their proximity to forests, protected areas, and fallow lands. The questionnaires were pretested at Birem before the main interview was carried out. In all 200 commercial charcoal producers in the district were interviewed (forty producers per community). The

Table 1. Age, gender, marital status, dependants, education and years of experience of respondents.

Age range (Years)	No. of respondents/%	Gender	No. of respondents/%	Marital status	No. of respondents/%
16–20	10 (5)	Female	16 (8)	Married	142 (71)
21–30	44 (22)	Male	184 (92)	Single	48 (24)
31–40	56 (28)			Others	10 (5)
Above 40	90 (45)				
Total	200 (100)	—	200 (100)	—	200 (100)
No. of dependants	No. of respondents/%	Education	No. of respondents/%	No. of years of experience	No. of respondents/%
1–5	94 (47)	No schooling	92 (46)	1–5	94 (47)
6–9	54 (27)	Basic level	80 (40)	6–10	42 (21)
Above 10	52 (26)	Secondary	28 (14)	Above 10	64 (32)
		Tertiary	0 (0)		0 (0)
Total	200 (100)	Total	200 (100)		200 (100)

Source: Field survey 2017/18

interviews were conducted on a communal labor day of each community (a day set up to clean the community). This was to make it possible for the respondents to have time for the exercise. All respondents were interviewed individually in their homes and in the local dialect (Twi). The questionnaire comprised closed and open questions to provide qualitative and quantitative data. In each community at least 20 producers (focus group) were met as a group to discuss the issues concerning the activity and notes were taken to be incorporated in the findings.

2.3. Reconnaissance survey

A day was spent in each of the communities to carry out a reconnaissance survey. The aim of the survey was to assess and identify the vegetation types (i.e. primary or secondary forest), the land use systems including mixed cropping, land rotation, agroforestry systems, etc, and their effects on the vegetation cover in each community. Each recce survey consisted of about four kilometers walk using the bush paths created by farmers and hunters. A volunteer farmer in each community led the process using a chosen direction away from the village. As the walking progressed and observation went on, notes were taken and questions asked and answers were also taken till the end of the walk back to the community.

2.4. Determination of the relative abundance of tree species

The frequency method defined as the chance of finding a species in a particular area in a sample, was used to determine the relative abundance of species in the study sites. Two sites each measuring about one hectare were used. The experimental site was a forest area which is used for charcoal production and the adjacent forest area not used for charcoal production served as a control site. In each site an area of 640 meters square was delimited and divided into 64 square plots within each of which four 5 meters' quadrats were marked at random and presence or absence of trees in quadrats were recorded for the individual tree species. The frequencies and the relative abundance of tree species were calculated using the formulae according to Grig-Smith (1983):

Frequency = $\frac{\text{Number of quadrats with species } x}{\text{Total number of quadrats used}}$.

Percentage (%) relative abundance = $\frac{\text{Frequency of species } x \times 100}{\text{Sum of frequency values of all species}}$.

These percentages were then expressed as Domin value according to Braun-Blanquet (1932) cited by Dogbe 2001.

3. Results

3.1. Age, Gender, Marital statuses, number of dependents, education and years of experience of respondents

The study revealed that a wide range of age groups were involved in the charcoal production business as shown on table 1. The respondents in their teens (16–20 years old) was made up of only 5%, while those from 21–30 years old were about 22% and that of 31–40 years and those above 40 years old formed 28% and 45% respectively. Female producers were 8% as compared to their male counterparts with 92%. This data therefore suggest that more men in the study area are into the charcoal production business as compared to their female counterparts. Seventy-one percent were married as against 24% who were single. In terms of dependents of

Table 2. Ethnic group, religious affiliation, major and supplementary occupation of respondents.

Ethnic group	No. of respondents/%	Religious affiliation of respondents	No. of respondents/%
Akan	60 (30)	Traditional	18 (9)
Sissala	64 (32)	Christianity	106 (53)
Others	76 (38)	Islam	76 (38)
Total	200 (100)	Total	200 (100)
Major occupation of respondent	No. of respondents/%	Minor occupation of respondent	No. of respondents/%
Farming	92 (46)	Farming	32 (16)
Charcoal production	86 (43)	Charcoal production	118 (59)
Petty trading	22 (11)	Petty trading	50 (25)
Total	200 (100)	Total	200 (100)

Source: Field survey, 2017/18.

respondents, the results varied with 47% having between 1–5 dependents, 27% with 6–10 dependents and more than 10 dependents was 26% of the respondents.

Results from the questionnaires showed that majority (46%) of the producers do not have basic education, while 40% have basic education with only 14% having secondary education (table 1). This result affirms a report by Ghana Living Standard Survey (GLSS 2014) that people with low level of formal education are more in the environmental resource exploitation business than those with high level of formal education. It was also established that respondents have varying number of years of experience in the charcoal production business where 42% have 1–5 years of experience, 27% was those with 6–10 years while 26% was those with more than 10 years. Information gathered showed that the industry is very old in the district with the aged deeply involved in it.

3.2. Ethnic groupings, religious affiliation. Major and supplementary occupation of respondents

The people engaged in the charcoal production activity as shown by the survey indicated that the Sissalas dominated the venture forming 32%, followed by the Akans ethnic group (table 2) More than 50% of the respondents engaged in the venture are Christians followed by those who profess the Islamic faith. The results as presented in table 2 showed that the Sekyere Central District is about 70% rural with agriculture (farming) as the predominant occupation. However other activities are carried out to supplement the income of the people especially during the off-farming season. Majority of the respondents (46%) were farmers and 43% being full-time charcoal producers while 59% are into charcoal production as part-time occupation. Farming and trading had 16% and 25% respectively as part time jobs.

3.3. Frequency of charcoal production, source of labor and tree felling methods

Production frequency, source of labor and tree felling methods are crucial in charcoal production and for that matter tree resource utilization and conservation. Fifty-nine percent (59%) of the respondents produce charcoal every two months, while 28% produce occasionally and only 13% produce charcoal on monthly basis (table 3) Cost of labor, contributes to the high cost of the business, and so producers who rely on hired labor formed 13% and those who use family labor constituted 41% with those who combine both family labor and hired labor making 46% (table 3). In terms of tree felling method, 25% of the respondents use chainsaw only while 21% use the axe and cutlass only. Fifty-four percent (54%) use axe, cutlass and chainsaw with a reduction in cost by 50% (table 3).

3.4. Production level, method of production, total expenditure, total income, types and source of raw materials of respondents

The method of charcoal production by respondents is very important in commercial charcoal industry, as there are many economic and health implications associated with it. The results indicated that all respondents (100%) use the traditional Earth mound method (table 4). Respondents who produce between 200–500 maxi bags year⁻¹ were 21%, 45% produce 600–1000 maxi bags and those with over 1000 maxi bags were 34%. In terms of average expenditures, 33% spend up to three thousand cedis (GHC3000.00) while those who spend between three thousand one hundred Ghana cedis (GHC3100.00) and five thousand Ghana cedis (GHC5000.00) formed the largest group (50%) and 17% of the respondents spend over five thousand cedis per production. The survey also brought to light that up to five thousand cedis (GHC5000.00) is realized as income per production by 46% of the respondents. Thirty-six percent (36%) get between five thousand one hundred Ghana cedis and ten thousand cedis (GHC 5100-GHC10,000.00) while those who get above ten thousand cedis is made of 18% of the respondents.

Tree species	Experimental plot	Control plot
<i>Alstonia boonei</i>	1	2
<i>Parkia biglobosa</i>	1	3
<i>Ceiba petandra</i>	1	1
<i>Anogeissus leiocarpus</i>	1	4
<i>Terminalia ivorensis</i>	2	5
<i>Tetrapleura tetraptera</i>	1	4
<i>Afzelia africana</i>	2	4
<i>Margaritaria discoidea</i>	2	2
<i>Erythrophleum ivorense</i>	2	3
<i>Afzelia bella</i>	2	4
<i>Strombosia glaucescens</i>	1	5
<i>Parinari excelsa</i>	1	1
<i>Nesogordonia papaverifera</i>	1	4
<i>Mamea africana</i>	1	3
<i>Hymenocardia acida</i>	1	4
<i>Khaya senegalensis</i>	1	2
<i>Lophira elastica</i>	1	4
<i>Funtumia elastica</i>	1	4
<i>Bombax brevecuspe</i>	1	4

Figure 2. Relative abundance of tree species in the study site.

The types of raw materials used for charcoal production varied from locality to locality. Sixty-two (62%) percent use live trees while 38% use dead trees. In terms of source of the raw materials, 81% of the respondents use both live and dead trees on fallow lands outside the forest reserves as against 19% who use wood from farms after farmers have burnt the trees for farming.

The information gathered from the charcoal producers and other informants in all the study communities identified some tree species as preferred for charcoal production due to certain qualities as presented on table 5 below.

3.5. Knowledge of conservation practices, common degradations and their perceived causes in the communities

Sixty-nine percent (69%) of respondents selectively fell mature trees and 16% use controlled burning in order not to destroy the vegetation and 3% adopt fallowing to allow natural regeneration (table 6). This study reveals that natural regeneration is the main strategy of forest conservation which affirms a report on Forest Depletion in Ghana by Amoah and Korle (2020) that land degradation is increasing at alarming rate due to lack of tree planting culture but more reliance on natural regeneration. Eleven percent (11%) of the respondents does not

<i>Glyphaena brevis</i>	1	2
<i>Senna samea</i>	1	4
<i>Petersianthus macrocarpus</i>	1	4
<i>Daniellia oliveri</i>	2	4
<i>Khaya ivorensis</i>	2	3
<i>Parkia ficoidea</i>	2	4
<i>Vitellaria paradoxa</i>	2	4
<i>Albezia feruginea</i>	1	2
<i>Milicia excelsa</i>	1	4
<i>Tectona grandi</i>	1	3
<i>Morinda lucida</i>	1	1
<i>Antiaris toxicaria</i>	1	1
<i>Holarrhena wulfsbergii</i>	1	4
<i>Celtis zenker</i>	2	2
<i>Triplochiton scleroxylon</i>	1	1
<i>Uapaca heudelotii</i>	1	2
<i>Terminalia glaucescens</i>	1	3
<i>Belanites wilsoniana</i>	1	2
<i>Nauclea latifolia</i>	2	4
<i>Parkia bicolor</i>	2	5
<i>Manilkara obvata</i>	2	3
<i>Mangifera indica</i>	1	3
<i>Borassus aethopicum</i>	2	2
<i>Pleiocarpa mutica</i>	1	2
<i>Milicia regia</i>	1	1
<i>Celtis malbraedii</i>	2	2
<i>Albezia zygia</i>	2	2
<i>Terminalia superba</i>	1	4
<i>Daniellia ogea</i>	1	3
	Experimental plot	Control plot
Domain value Scale: 5=constantly present; 4=mostly present; 3= often present; 2=seldom present, 1=rare		
Field Survey, 2017/18		

Figure 2. (Continued.)

practice any conservation method. In respect of types of degradation in the communities, 43% of the respondents believe deforestation tops all forms of degradation, 29% indicated soil fertility decline leading to low yields of their crops. Eleven percent (11%) complained of drying up of water bodies while 13% recognized soil erosion and 4% acknowledged the presence of all the degradations mentioned above.

Table 3. Charcoal production frequency, labour source and tree felling method of respondents.

Production frequency	No. of respondents/%	Sources of labour	No. of respondents/%	Tools used in tree felling	No. of respondents/%
Monthly	26 (13)	Family	82 (41)	Chain saw	50 (25)
Bi-monthly	118 (59)	Hired	26 (13)	Axe/cutlass	42 (21)
Occasionally	56 (28)	Family and Hired	92 (46)	Cain saw and Axe/cutlass	108 (54)
Total	200 (100)	Total	200 (100)	Total	200 (100)

Source: Field survey, 2017/18.

Table 4. Production level, method of production, total expenditure, total income, types and source of raw materials of respondents.

Production level (50 kg/bag)	No. of respondents/%	Production method	No. of respondents/%
200–500	42 (21)	Traditional	200 (100)
501–1000	90 (45)	Improved (kiln)	0 (0)
Above 1000	68 (34)		
Total	200 (100)	Total	200 (100)
Total expenditure (GHC)	No. of respondents/%	Total income (GHC)	No. of respondents/%
Up to 3000	66 (33)	Up to 5000	92 (46)
3100–5000	100 (50)	5100–10 000	72 (36)
Above 5000	34 (17)	Above 10 000	36 (18)
Total	200 (100)	Total	200 (100)
Types of raw materials used	No. of respondents%	Sources of raw materials used	No. of respondents%
Dead trees	124 (62)	Farms	38 (19)
Dead and Live trees	76 (38)	Fallow lands	162 (81)
Timbers waste	0 (0)	Timber concessions	0 (0)
Total	200 (100)	Total	200 (100)

Source: Field survey, 2017/18.

Table 5. List of preferred tree species for charcoal production.

Scientific name	Common/local name
<i>Terminalia avicenioides</i>	Ongo
<i>Terminalia ivorensis</i>	Sese
<i>Holarrhena wulfsbergii</i>	Emire
<i>Tetrapleura tetraptera</i>	Prekese
<i>Erythrophleum guineense</i>	Potrodum
<i>Anogeisus leiocarpus</i>	Kane
<i>Daniellia oliveri</i>	Senya
<i>Afzelia bella</i>	Papao
<i>Manilkeria multinervis</i>	Brekankum
<i>Lophira alata</i>	Kaku
<i>Piptadeniastrum afriacana</i>	Dahoma
<i>Strombosia glaucescens</i>	Afena
<i>Amphimas pterocarpoides</i>	Yaya
<i>Combretodendron marcocarpum</i>	Esia
<i>Dialium aubrevillei</i>	Duabankye
<i>Pentandethra macrophylla</i>	Ataa
<i>Parinari excels</i>	Ofam
<i>Nesogordonia papaverifera</i>	Danta
<i>Khaya anthotheca</i>	Dubini (mahogany)
<i>Khaya senegalensis</i>	Esereso dubini
<i>Khaya ivorensis</i>	Dubini nua
<i>Klainedoxa gabonensis</i>	Koroma
<i>Celtis malbraedii</i>	Esa
<i>Vitellaea paradoxa</i>	Nku dua (shea tree)
<i>Parkia biglobosa</i>	Dawadawa tree

Source: Field survey, 2017/18.

Table 6. Conservation practices, types of degradation identified, perceived causes of degradation and bushfires and ways to avoid fires in the communities.

Conservation type	No. of respondents/%	Degradation type	No. of respondents /%
Selective felling	138 (69)	Deforestation	86 (43)
Replanting	2 (1)	Soil fertility decline	58 (29)
Fallowing of land	6 (3)	Drying of waterbodies	22 (11)
Controlled burning	32 (16)	Soil erosion	26 (13)
None of the above	22 (11)	All the above	8 (4)
Total	200 (100)	Total	200 (100)
Perceived causes of degradation	No. of respondents/%	Perceived causes of bushfires	No. of respondents/%
Over extraction of trees	32 (26)	Charcoal production	12 (6)
Farming activities	14 (7)	Fulani herdsmen	52 (26)
Chainsaw operations	18 (9)	Game hunting	64 (37)
Timber extraction	8 (4)	Farming activities	12 (6)
Annual bushfires	52 (26)	All the above	50 (25)
All above	56 (28)		
Total	200 (100)	Total	200 (100)
Suggested measures to control bushfires	No. of respondents/%	Responses on Banning of Charcoal Production	No. of respondents/%
Severe punishment	88 (44)	Yes	14 (7)
Education of people	86 (43)	No	186 (93)
Banning of certain activities	26 (13)		
Total	200 (100)	Total	200 (100)

Source: Field survey 2017/18.

Respondents' perception regarding the cause (s) of the degradation showed that 26% were of the view that fuelwood cutting and charcoal production activities contribute to the degradation (table 6). Another 26% perceive annual bushfires are the cause, while 9%, 7%, and 4% of the respondents blamed chainsaw operators, farming activities and timber contractors respectively. There was a last group (28%) that believed all the activities and operations mentioned above cause the degradation. All respondents (100%) confirmed the existence and seriousness of all the aforementioned activities. Charcoal production as a cause of fires was by 6%, while 26% and 37% of them attributed the bushfires to Fulani herdsmen and hunters respectively. Some respondents (6%) believe farming activities is the main contributor to the fires and finally 25% of them say all the activities above are the cause to the bushfires. The respondents suggested measures to reduce/prevent annual bushfires in their communities. Forty-four percent (44%) of the respondents advocated for severe punishment of offenders while 43% and 13% of them prescribed education of the general public and banning of some activities respectively (table 6). Only 7% of the respondents suggested banning of the trade while 3% did not support the idea saying it would bring about increased crime in the villages since charcoal production is a major occupation and a source of income for many.

3.6. Forest types, land use system and the relative abundance of tree species on the study site

During the reconnaissance survey in all the communities; the vegetation was predominantly secondary forest with patches of primary forests along some water bodies as reported by Ghana Statistical Service (2014). Other places with primary forests were shrines and sacred groves and the Kogyae Strict Nature's Reserve under the management of the Wild Life Division (WD) of the Forestry Commission (FC). Common tree species in the communities include *Anogeisus leiocarpus*, *Ceiba petandra*, *Mitrogyna spp*, *Vitellaria paradoxa*, *Senna samea*, *Parkia biglobosa*, *Bombax brevisuspe*, the Albezias, etc. Large portions surrounding the communities were grasses as continuous farming and the exploitation of wood has changed the vegetation. Grasses such as the Elephant grass (*Pennisertum purpureum*), Spear grass (*Imperata cylindrica*), Northern gamba grass (*Andropogon gayanus*), the Seame weed (*Chromolaena odorata*), etc dominated most places (ibid).

The land use systems in the studied communities and for that matter the district are similar in all aspects as there is migration of people between these communities and other settlements in the area by settler farmers and even the indigenous people (ibid). The main land use system is agriculture as it is the major occupation of the people in the district (ibid). The Kogyae Strict Nature's Reserve occupies a significant land that is protected. There are also a number of public and private forest plantations of teak (*Tectona grandis*) in all these communities. Woodlots were also established in some of the communities with the support of some Non-Governmental Organizations (NGOs) such as ADRA-GHANA and the WORLD VISAON-GHANA. The other important land use system identified during the reconnaissance survey is pastoralism in all the communities practiced by Fulani herdsmen who have migrated from the northern part of Ghana and even Burkina Faso. Few indigenous people do own cattle but their grazing is restricted to along the main roads and farm tracks. Finally, charcoal production has also taken roots in these communities by the Sissala ethnic group, other migrant farmers and some indigenous people. Felling of tress such as

Potrudum (*Erythrophleum ivorensis*), the Dawadawa tree (*Parkia biglobosa*), the shea nut tree (*Vitellaria paradoxa*), etc for charcoal is common in these communities appendix A (figures A2 and A5). The frequency or otherwise of tree species in the study sites showed that the control plots had more tree species as opposed to the experimental plots as shown as domain values in figure 2.

4. Discussion

4.1. Demography of the respondents

The charcoal producers in the area who are in their teens are very few in the industry. This is probably due to the fact that this category is school going age, since they make up only 5% of the respondent. Those within 21–40 years are 50% while those over 40 years make up a 45% (table 1), which is in keeping with the report by Ahmed *et al* (2021) in Nigeria where they realized that charcoal production was a source of livelihood for the youth. The 21–40 years' age group is a strong and active group in every sector of the economy. Those over 40 years are also significant since they make up 45%. The large percentage of the 21–40 years' age group could be due to the fact that the industry has become lucrative since the products are not perishable like agricultural goods, and any delay in the sale would not affect the quality and price. The other factor could be due to the poor agriculture production in recent times, coupled with poor prices and high agriculture input prices, therefore most of the youth group have taken 'refuge' in this sector for a living. Unlike in the early days where only old people were involved, the study has proven that charcoal production is not really for the aged now confirming Ahmed *et al* (2021), where the youth see the venture as a source of livelihood. A respondent at Birem said he was seriously producing charcoal to accumulate money for his tertiary education since he has no financial support. It is a male dominated enterprise as few women are involved due to several factors including the drudgery in it (Ahmed *et al* 2021, World Bank 2022), which contradicts observation by Ricerca Cooperazione (2011) which reported that over 80% of commercial charcoal and firewood producers in Ghana are women. Incidentally, all the female respondents were Akans, and quite grown. It was realized that in the Sissala communities, females do not involve much in charcoal production on their own. They only provide food when the men are working or assist the men in carting charcoal from the production sites. However, there are more women into the marketing of the product (charcoal) at the markets and in the towns at both Mampong and Nsuta (the district capital). They make up over 80% of the dealers in these markets. As indicated on table 1, majority of the respondents were married with families as such one can confidently say that the charcoal production plays a significant socioeconomic role in the district as it is either a main source of income or serves as a supplementary income source for many rural households (World Bank 2022). This also confirms earlier works that found out that 41% of charcoal producers earn up to the national minimum wage in Nigeria (Ahmed *et al* 2021). In terms of the majority of the respondents being illiterates or semi-literates, it agrees with Ahmed *et al* (2021) where 68% of producers had no education.. Only 14% of the respondents had up to secondary education with none up to the tertiary level. This means that the industry is not attractive to educated people but to the less privileged who find the job attractive, as reported by Nketia *et al* (1988). With regards to number of years of experience, all respondents have produced charcoal for at least one year. A good number (42%) of respondents have had one to five years of experience which indicates that more people are entering the industry which means more extraction of trees for the trade. Some of the youth say there are no jobs and therefore almost every young able man in the Afram Plains portion of the district produces charcoal especially during the dry season.

4.2. Ethnic groupings and religious affiliation or believes

It has been found out from the study that unlike in the previous times, the Akans are now into the charcoal production seriously as they formed 30% of all respondents. This is an indication that the business is no more Sissalas' or migrant farmers' affair as was in the past (Nketia *et al* 1988, World Bank 2022). The implication here is that since indigenous people are now involved, and have relatively easy access to land, adopting measures to maintain the tree resource base by way of replanting trees or observing other conservational practices should not be a problem. They need encouragement and motivation to ensure the adoption of forest vegetation conservation. The Sissalas still make a significant portion of the charcoal producers especially those who produce hundreds of bags and cart to the urban centers for sale. According to Agyei *et al* (2018), charcoal production was historically dominated by people of the Sissala ethnic group from Upper West Region of Ghana, who moved from village to village to produce charcoal. Anecdotal reports from Kintampo South district of the Bono East region of Ghana indicates that charcoal even became known as 'Sissala cocoa' (UDS Survey, 2022 cited in World Bank 2022). Other ethnic groups mostly settlers are also into the business and hence the high proportion of non-indigenous people of 70% of the respondents which have negative implications since these people do not own land and may not make any serious efforts to conserve the vegetation as reported by Nketia *et al* (1988). Mensah and Agyare (1994) have stated that settler/migrant farmers or producers do not have

interest in planting trees after extraction and production of charcoal which is impacting seriously against the forest cover. The study revealed that majority (53%) of the respondents was Christians and 38% Moslems whereas only 9% were Traditional believers. It has been found that Sissalas and other migrant settlers involved in charcoal business are predominantly Moslems, while Akans are also predominantly Christians. What it means is that certain cultural believes such as taboos which were used as measures for the conservation of natural resources in the past may not be well observed now.

The importance of the faith professed by these ethnic groups may be enormous in respect to the conservation of the forest resources. For example, the adherents of the Traditional religious faith conserve portions of forests as fetish groves while Christians especially the Charismatic, consider such sacred areas as fetish and must be destroyed. Forests were regarded as sacred natural endowment with all its life forms, playing significant cultural and religious functions with intrinsic right to exist (Abenney 1999). As a result, appropriate sacrifices were performed to honor the ancestral forest deities during festivals, and also to pacify them when the ecosystem was disturbed by removal of trees like *Milicia excelsa*, *Adonsonia digitata*, etc (ibid). The use of cultural symbols as a way of traditional conservation (Mperreh 1992), may not be observed by migrants who do not have knowledge or appreciate it because of cultural differences and believes. Unfortunately, with the gradual decline of faith in the traditional religion, some believes and practices are not observed by today's Christians and Moslems which also have negative effects on traditional conservation methods.

4.3. Respondents occupations and frequency of charcoal production

Many of the producers either depended mainly on charcoal production as their major income activity or as a supplementary income activity which is in keeping with Anang *et al* (2011), where producers said they will starve if charcoal production was to be banned in the area. Most of the Sissalas and some of the young Akan producers have charcoal production as their main occupation with farming as a supplementary income or food source as reported in earlier findings (Brefo *et al* 2012, Ahmed *et al* 2021, World Bank 2022). Others do petty trading such as sale of provisions, drinks, etc. It has been established that over 80% of the respondents especially the youth wished they had something else to do either than charcoal production. This means if the economy improves and there are jobs, a good number of the youth in the industry would greatly decline as found at Gishiegu in northern Ghana (Anang *et al* 2011).

The frequency of charcoal production depends on the availability of raw materials, availability of labor and market of the produce. It was realized that 59% of respondents produce charcoal every two months and depend on the industry for a living especially the Sissalas, and any break in the production cycle means no income for the family for that period as reported by Brefo *et al* (2012). The producers use different sources of labor such as family labor and hired labor for the production of charcoal. Hired labor formed a large proportion of the respondents' labor source followed by the family labor. Majority of the respondents depend on both family and hired labor since according to Nketia *et al* (1988) labor contributes 50% of the total production cost. That is probably why producers supplement hired labor with family labor to reduce cost so as to maximize profit.

The bulk of the labor is used on tree felling, cutting of trees into billets and packing of the billets in pit to form the Earth mound. Again, due to high cost of hiring the chainsaw, producers often use axe and cutlass after felling to chop smaller trees and branches. Others use axe and cutlass especially on farms where trees are smaller in size. Since chainsaw is fast and capable of felling larger trees with ease, the implication is that large scale producers would obviously depend on it. Nketia *et al* (1988) have observed that a production gang of 10 men could exploit an area of 260 acres of land of its suitable tree species in 12 months using chainsaws. It is therefore worrying for the fast depletion of tree resources without serious efforts put in place for the continuous use of this resource. The use of axe and cutlass even though primitive, is less destructive as bigger trees are slowly removed and the general speed of tree removal is slower than chainsaw. The traditional Earth mound is the only method known and used by the producers in the district confirming similar finding by Nketia *et al* (1988) and Mensah and Agyare (1994). About 5% of the respondents either read or heard about the improved methods but said they have not had the opportunity of seeing how it is done. There are three groups of charcoal producers in the district. The first group which could be considered as small scale ranged from 200–500 maxi bags of 50 kg. The majority of the respondents produce between 600–1000 maxi bags and considered as medium scale, while the large scale producers of charcoal are those who produce over 1000 maxi bags. With these huge volumes produced from the forests in the district, one may be concerned about its impact of the forest vegetation.

4.4. Types and sources of raw materials

The type of raw materials and their sources for charcoal production according to majority of respondents are from both dead and live trees farms, fallow lands and forests confirming earlier reports (Lurimuah 2011, Ricerca Cooperazione 2011). It was revealed by informants that some producers even cart over 1000 bags of charcoal per trip to Accra. It is therefore significant to note that a large volume of trees (wood) are being used to produce the charcoal in the district and if measures were not taken the resource base would be endangered. A study

conducted in the then Sekyere West district which this district was part by Kass-Yerenchi (2002), indicated that about 2,070 maxi bags per day were carted from Mampong alone to the cities. It did not include figures for local consumption within the district. As an industry where entry and exit are not regulated and does not need so much know-how or training to start, one cannot deny that it plays a major socioeconomic role in the district as it employs a lot of young men and women especially those selling at the markets. The life wire of every industry is marketing of its products, and the charcoal industry in the district has no problem with marketing. Unlike agricultural commodities with post-harvest problems, charcoal has no shelf life and is also enjoying a favorable demand as a result of the current price hikes of crude oil internationally and locally. It is easy to store and handle for long distances without losing its quality. Therefore 33% of the producers interviewed cart the charcoal to the cities where market is higher than at the local level. This is keeping with Nketia *et al* (1988) and Anang *et al* (2011) where they reported that the bulk of the commodity sold in Accra, Kumasi, Obuasi, Tema, etc are from the Savanna and the transitional zones. The local demand is now higher since many workers cannot afford the continuous use of Liquefied Petroleum Gas (LPG) and have to totally depend on the charcoal for domestic use. For the industry to remain viable, to meet the needs of the increasing population in the district and the country as a whole, stakeholders must ensure the sustainable wood exploitation for the production of charcoal.

It is worth saying that field observations during the study period, revealed that charcoal producers use more of the live trees (Lurumuah *et al* 2012) than dead trees since dead trees are scarce except where the trees are burnt for farming purposes. However, producers knowing the adverse effects of their activities would deny using live trees including economic and fruit trees. It was realized that trees such as the mango, the dawadawa, the sheanut, etc and other timber species were being used secretly by producers as reported by Nketia *et al* (1988) and Obiri *et al* (2014). In the present study, majority of respondents get their raw materials from fallow lands. Again, observations and information from the Forest Service Division suggests that some producers illegally fell trees in the reserves and are sometimes arrested and their produce seized and auctioned to the public. Nketia *et al* (1988), Owusu *et al* (1998) and Mensah and Agyare, (1994), and World Bank (2022) confirmed this practice by charcoal producers.

4.5. Quality of tree species for charcoal production and conservation practices against degradation in the district

According to the producers, suitable tree species used for charcoal production must have some qualities including but not limited to the ability to catch fire easily, high calorific value, produces less ash, produces less smoke and does not explode as was reported by the Ministry of Energy (2019a). Some of the trees these produce high quality charcoal and are mostly fruit and/ or timber species which are protected by national or traditional laws (Lurumuah 2011, Lurumuah *et al* 2012). Producers in the district interviewed listed some of the common trees they use for the charcoal production as shown in table 5.

All land users whether farmers or charcoal producers have some level of knowledge of conservation practices that replenishes the used tree resources. It is therefore not surprising that 67% of the respondents claimed they practice selective felling of mature trees. Controlled use of fire is adopted by some respondents (13%) and fallowing by 9%. Unfortunately, 11% said they do not practice any of these consciously with the aim to conserving the resources. This is in keeping with Nketia *et al* (1988) who reported that tenants do not want to spend money on conservation practices on land which their continuous stay is not guaranteed. Again as said earlier, because farming is quite becoming unpopular in the district due to poor yields, poor prices of farm produce and high production costs, in addition to the ever increasing rate of unemployment in the country many people in the communities resort to charcoal production since it does not need so much capital to start and has less risks. Observations and responses from informants indicate a low farm output in recent years due to soil degradation. The emergence of notorious weeds such as the spear grass (*Imperata cylindrica*) is a clear manifestation of fertility decline in most parts of the district. Water bodies continue to dry every dry season as riparian vegetation has been removed thereby accelerating soil erosion leading to siltation of these water bodies. Its consequence has been shortages of water for the rural people and their livestock.

There are certain perceived causes of these degradations as given by the respondents in the district. Charcoal production and annual bushfires were identified by 52% of the respondents as the main causes of these degradations as presented on table 6. Chainsaw operation, farming activities and timber logging were perceived to be the cause of degradation by few respondents (20%). There was a last group (16%) that believed all the activities mentioned contribute much to the forest degradation. They attributed annual bushfires as a menace throughout the district and that charcoal production is the principal cause of these fires which agrees with earlier reports which identified charcoal production as one of the main causes of bushfires and nutrient depletion in Ghana (Anang *et al* 2011), and deforestation in Ethiopia (Damte and Koch 2011). Some respondents (12%) accused Fulani herdsmen (nomadic herdsmen) and hunters as the cause of most bushfires with only a few (4%) of the respondents blaming farming activities. However, Nketia *et al* (1988), Mensah and Agyare (1994), and

Kass-Yerenchi (2002) in their earlier works blamed charcoal producers for the bushfires menace. In the present study during personal observations and from informants it could be concluded that charcoal producers and hunters are the key starters of bushfires. For instance, carbonization of the wood in the Earth mound sometimes take two to three weeks and strong harmattan winds in the dry season could carry the fire from the Earth mound to any nearby vegetation. The measures to prevent or reduce the annual bushfires varied among respondents as indicated on table 6. Majority (50%) of the respondent prescribed severe punishment for offenders while 43% believed education of the general public could help solve the problem. Some even advocated for the banning of certain activities such as group hunting. In respect of banning commercial charcoal production, majority (93%) did not subscribe to that as earlier reported by Anang *et al* (2011), while only 7% of the respondents agreed to the banning as a measure to reduce bushfires and further degradation of the forest.

4.6. Problems associated with the charcoal industry

There were three major problems identified which affect the industry. Forty-seven percent (47%) were of the view that raw materials base is exhausted and one has to go to far and less accessible sites for suitable tree species as reported by Brobbey *et al* (2015). This they say increase the cost of production thereby reducing their profit margin. They observed that over exploitation of suitable tree species for charcoal and farming activities contribute to this problem. According to the study, producers are therefore forced to mix poor quality tree species with the few suitable species they get to increase the quantum of the charcoal as reported by Nketia *et al* (1988), Chauchau (1993a) and Kass-Yerenchi (2002). Inadequate finances/lack of financial support were another problem respondents considered crucial. They wished they had assistance to establish and maintain tree plantations or woodlots to replenish the exploited trees. The third group of respondents said both raw materials and the finances are equally serious problems affecting the business. These views as genuine problems and could be attributed to lack of education of the producers to sustainably exploit the raw materials and to adopt simple business management like record keeping, savings with financial institutions especially rural banks, formation of cooperatives, etc to enable them secure loans.

4.7. Forest types and land use system, relative abundance of tree species in the district

The vegetation in the study area has virtually turned to secondary forest as a result of over exploitation of the forest, and other land uses such as agriculture, pastoralism, etc (GSS 2014). The effects of these activities could have been exacerbated by the rapid increase in population due to migration, increase in birth rate, etc (ibid). The vegetation is dominated by grasses, due to the persistent fires and the removal of trees thereby making conditions favorable for the pioneer species to invade the area (figure A5). As indicated by the respondents, the decline in soil fertility encourages noxious weeds to take over many of the lands in the district. Trees like *Anogeisus leiocarpus*, *Erythrophleum guineense*, *Mitrogyna spp.*, etc are common but under pressure as charcoal producers over exploit them as earlier reported by Chidumayo and Gumbo (2012) and Adeniji *et al* (2015). In the Afram Plains part of the district, yam farming is on very large scale, and when the vegetation cover is cleared to give way for the yam fields charcoal producers take advantage and cut down all dead trees as revealed during the study. As indicated by Hall and Swaine (1981), a notorious weed, *Chromolaena odorata*, a wind dispersed plant colonizes the vegetation; smother seedlings and saplings of trees and serve as a fuel during the dry season for bushfires. This impedes natural regeneration of the suitable tree species that are heavily exploited for charcoal.

The land use systems that have negative implications for forest management in the district are farming, charcoal production and group hunting commonly called 'floata'. Farming systems throughout the district as are generally similar. As a rural district, farming is the major occupation with shifting cultivation as a common system aimed to replenish soil nutrients during the fallow periods. The study revealed that due to population pressure on the fix land as a result of migrants to the area, per capita land size has decreased, fallow periods reduced. Earlier works suggested that in Ghana, fallow periods have reduced from 20 years after World War II to 10 years or less in the 1970s and more recently to as little as 2–3 years in many localities (Persson 1997, Ministry of Food and Agriculture 2021). The private tree plantations and woodlots have positive implications as it contributes to the soil and water conservation through the reduction of erosion and serves as a habitat for wildlife. The few Non-Governmental Organizations that are into woodlots demonstrations for their clients if well taken by the farmers would contribute to biodiversity conservation.

From the reconnaissance survey in all the communities and what was found at the experimental plot where trees were exploited for charcoal production, there were fewer number of tree species than the control plot (which was fallow for several years). The species such as Verbanaceae, Miliaceae, Guttiferaceae and Erythroxylaceae were scarce as they are suitable timber species and at the same time illegally used for charcoal production. In all, the tree species on the control field were more than that of the experimental field which can be attributed to the extraction of these tree species for charcoal production.

5. Conclusion

The study brought to the fore that charcoal production will continue as an economic venture for some time as long as Ghanaians continue to depend heavily on charcoal and firewood as a means of meeting their domestic energy needs (cooking and heating). The Akans (indigenes) who hitherto were not in the trade have found the business lucrative and as such have joined the Sissala people who traditionally are known to be involved in charcoal business. What this means is that if more of the indigenes (Akans) continue to go into the trade and with conscious education on conservation management practices, there should be positive results as most of them could be from families owning lands. As it is now, the rate of wood extraction as well as conservation measures does not allow adequate regeneration of the suitable tree species for the sustainability of the venture.

Unemployment and its associated social issues such as poverty, deprivation, etc are compelling many people especially the youth to take up charcoal production as a means of livelihood. This trend is most likely to continue for some time since the agriculture sector is not attractive to the youth due to many challenges like high cost of inputs, unreliable rainfall, low prices of farm produce, etc.

The traditional Earth mound is the main method of charcoal production in the district and known to waste a lot of raw materials, less efficient (believed to waste material), has adverse health effects on the producers and more likely to cause bushfires especially in the dry season (Lurumuah 2011), and should be of concern to the general public. Environmentally, loss of vegetation, soil loss and water quality and quantity are closely interrelated which affects dry season agriculture (Chidumayo and Gumbo 2012), which may lead to more people entering the charcoal production business. The major stakeholders and their roles to promote the industry or curb the degradations have been identified. These include the District Assembly, the highest authority in the district to lead and collaborate with the traditional councils and land owners. The other key actor institutions are the Forest Services Division, Ministry of Food and Agriculture, Department of Cooperatives and Non-Governmental Organizations with a common vision of educating, monitoring and sponsoring some of the activities of these producers to ensure the sustainable use of the trees since it is almost impossible to do away with charcoal production in the district.

For now, it may not be easy to ban charcoal production as an economic venture in Ghana and for that matter in the Sekyere Central District as reported in other parts of the country where youth indicated it is their means of livelihood (Lurumuah 2011). Therefore, there is the need for concerted efforts by all stakeholders to be spearheaded by the District Assembly to establish a policy framework to modernize the industry holistically. This could be achieved by establishing woodlots/ plantations in the state owned lands for the provision of raw materials, use of improved production methods, the adoption of conservation measures, etc to protect the environment.

5.1. Recommendations

Since charcoal continuous to be the major source of fuel for the majority of Ghanaians, its production especially in the rural areas will persist so long as there is demand for it. For the sustainable exploitation of our tree resources the following recommendations are made:

The District Assembly and the Department of Cooperatives should collaborate and register all producers in the district and issue them with production permits or licenses which are to be renewed yearly. This will ensure the smooth monitoring of their activities and provision of technical and financial assistance. There should be collection of fees (royalties) for trees felled, whether on-reserve or off-reserve by the Forest Service Division and a percentage paid to a reforestation fund to be established by the District Assembly which would be used to promote community woodlots/ plantation projects. Tree planting using fast growing tree species with high quality wood for charcoal production should be promoted. Agroforestry practices that would replenish declined soil fertility and at the same time provide wood for charcoal should be introduced to the communities by Ministry of Food and Agriculture.

Chiefs and land owners should be encouraged to release land readily and at concessionary terms to groups and individuals to establish these woodlots. The District Assembly should launch an anti- savannization program in the district and seek funding from NGOs and development partners to supplement the Assembly's share of the royalties collected by the Forest Service Division to assist in the promotion of reforestation. The use of timber and fruit trees for charcoal production should be outlawed with severe sanctions to offenders. Finally, there should be further research on the impact of heat on soil microbes and soil nutrients such as macro and micro soil elements at charcoal production sites as well as total ecosystem functions in the production sites.

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Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors. The data cannot be made publicly available upon publication because they are owned by a third party and the terms of use prevent public distribution. The data that support the findings of this study are available upon reasonable request from the authors.

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Appendix A. Photos from the study site



Source: Field survey, 2017/18

Figure A1. A community *Senna samea* (Cassia) woodlot initiated by ADRA-GHANA. Source: Field survey, 2017/18.



Source: Field Survey, 2017/18

Figure A2. *Parkia biglobosa* (dawadawa tree) felled for charcoal. Source: Field Survey, 2017/18.



Source: Field survey, 2017/18

Figure A3. Billets packed to form an Earth mound, Source: Field survey, 2017/18.



Field Survey, 2017/18

Figure A4. Charcoal partially exhumed from an Earth mound, Field Survey, 2017/18.



Source: Field survey, 2017/18

Figure A5. Grassland taking over parts of the area Source: Field survey, 2017/18.

Appendix B. Questionnaire for charcoal producers in the Sekyere Central district

Council for Scientific and Industrial Research (CSIR-Ghana)

Questionnaire for Charcoal Producers in the Sekyere Central District:

Note: This questionnaire is to provide Information for academic Purposes and the Information given would be treated as confidential.

Instructions: Write or tick in the appropriate space or box. Please probe for more Information.

Section A: personal Information of respondents

1. Name of respondent 2. Age range: 16-20 ☐ , 21-30 ☐ 31-40 ☐ 40 and above ☐
3. Sex: Male ☐ , Female ☐
4. Marital status: Married ☐ , single ☐ , other specify
5. How many dependants have you? 1-5 ☐ , 6-10 ☐ , More than 10 ☐
6. Education: None ☐ , Basic ☐ , Second Cycle ☐ , Tertiary ☐
7. What is your religion? Traditional ☐ Christianity ☐ Islam ☐ Other specify.....

Section B: General questions (both sexes)

8. What is your main occupation? Farming ☐ Charcoal production ☐ trading ☐
Other, specify.....
9. Which of the following is your other job?
Farming ☐ Charcoal production ☐ , Trading ☐ other, specify.....
10. How long have you been in the charcoal production business?
1-10 years ☐ -20 years ☐ above 20 years ☐
11. What ethnic group do you belong to? Akan ☐ , Sissala ☐ Other specify.....
12. Is there charcoal producers association in your community? Yes ☐ , No ☐ . If no, ☐
Why?
13. Do you belong to the association?, Yes ☐ , No ☐ , If no why?
14. Have you enjoyed any benefit(s) from the association? Yes ☐ No ☐ , if yes, what is it?
.....
And if No, why.....
15. Which of the following agencies do you interact most with in connection with your business?
District assembly ☐ , Forest services Division ☐ , MOFA ☐
other, specify
16. What do you think can be done to improve the interaction/relationship.....
.....

17. Have you enjoyed the following from any agency, be it governmental or non-governmental?
 Technical support ☐ , financial support ☐ none ☐ other, specify
18. How far are you from these agencies? 5-20 km ☐ , 21-40 km ☐ , Above 40 km ☐
19. How often do you produce charcoal? Monthly ☐ every two months ☐ , occasionally ☐
20. What is your source of labour? Hired labour ☐ family labour ☐ , both ☐
21. What is your tree felling method? Chain saw ☐ , Cutlass & axe ☐ both ☐ , other,
 Specify
22. What is your annual range of production?
 200-500 bags ☐ , 600-1000 bags ☐ , over 1000 bags ☐
23. What is cost (range) per production?
 Up to GHC 3000 ☐ , GHC3100-5000, above GHC5000 ☐
24. What is your income (range) from the sale of charcoal per production?
 Up to GHC5000 ☐ , GHC6000-10 000 ☐ above GHC 10 000 ☐
25. Does it worth being in the industry? Yes ☐ No ☐ Give reasons for your answer

26. Which of these production methods do you use? Traditional earthmound ☐ Improved kiln ☐
27. How do you sell your charcoal? Through local dealers ☐ , sent to cities ☐
28. Which of these agencies do you pay royalties/revenue to? District assembly ☐ , FSD ☐
 Other, specify
29. How much do you pay per bag? GHC5 ☐ GHC10 ☐
30. Which of the following raw materials do you use most?
 Dead trees ☐ , wastes/ twigs from felled timber trees ☐ , Live standing trees ☐
31. Which of the following is your source of raw materials? Forest reserves ☐ ,
 Farms/ fallow lands ☐
32. What land/tree tenure arrangement(s) is/are available to you for charcoal production?
 Rental of the land ☐ sharing of produce ☐
 If sharing, what is the ratio? 50%:50% ☐ , 33%:67% ☐ .
 If rental how much? GHC500-1500 for two to three years ☐ e GHC2000 for three to five years ☐
33. List five most commonly used tree species for charcoal production in your locality.

34. Which of the following conservation methods do you practice?
 a. selective cutting of mature trees ☐
 b. replanting of trees after production ☐

- c. fallowing for natural regeneration ☐
- d. control burning ☐
- e. all the above ☐
- f. other, specify
35. Which of these environmental degradation (s) is/are common in your community?
- a. Deforestation ☐
- b. soil fertility decline ☐
- c. soil erosion ☐
- d. drying up of water bodies ☐
- e. all the above ☐
36. What might have been the cause(s) of the degradation?
- a. over extraction of wood for firewood/charcoal ☐
- b. shifting cultivation ☐
- c. overgrazing ☐
- d. Chain saw operators ☐
- e. timber contractors ☐
- f. annual bushfires ☐
- g. all the above ☐
37. Does this community experience bushfires? Yes ☐ or ☐ if yes, which of these activities contribute most to the bushfires?
- a. charcoal production ☐
- b. Fulani herdsmen ☐
- c. palm wine tapping ☐
- d. hunting ☐
- e. farming activities ☐
- f. all the above ☐
38. Which of these measures could reduce/ prevent the reoccurrence of the bushfires?
- a. severe punishment ☐
- b. education ☐
- c. banning of certain activities ☐
- d. others specify
39. Should charcoal production be banned in the district?, Yes ☐ No ☐
- Give reasons for your answer.....
-
40. Give at least to important roles each of the stakeholders below that can promote the sustainability of the industry in the district.
- a. District assembly

.....
.....
b. Traditional authorities

.....
.....
c. Land owners

.....
.....
d. Producers

.....
.....
e. Forest service division

.....
.....
f. MOFA

Section c: female respondents only

41. Which of the following have you enjoyed as a special package for female producers?

Loan facility ☐ , training ☐ , none ☐ not applied ☐

42. Which organization provided these?

.....
43. Who decides on when to produce the charcoal? Female producer ☐ husband ☐

Other, specify

44. Who decides on what to do with income from your produce? Female producer ☐

Husband ☐ other, specify.....

45. Do you have the know-how to produce the charcoal? Yes ☐ No ☐ , if No how do You produce?.....
.....

Section D: Both sexes

46. Which of the following problem(s) do you think is/are seriously affecting the industry?

a. scarcity of raw materials due to over exploitation ☐

b. inadequate finances to manage the business sustainably ☐

c. both problems above ☐

47. What comment do you have?

.....
.....

THANKS VERY MUCH FOR YOUR TIME!

ORCID iDs

John Bokaligidi Lambon  <https://orcid.org/0000-0002-3605-4831>

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