The Charcoal Industry in Ghana: An Alternative Livelihood Option for Displaced Illegal Chainsaw Lumber Producers

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The mission of the CSIR Forestry Research Institute of Ghana (FORIG; www.csir-forig.org.gh) is to conduct high-quality, user-focused research that generates scientific knowledge and appropriate technologies to enhance the sustainable development, conservation and efficient utilization of Ghana's forest resources; and to disseminate the information for the improvement of the social, economic and environmental well-being of the Ghanaian people.

The mission of Tropenbos International (TBI; www.tropenbos.org) is to improve tropical forest governance and management for the benefit of people, conservation and sustainable development. By making knowledge work for forests and people, TBI contributes to well-informed decision making for improved management and governance of tropical forests. TBI's longstanding local presence and ability to bring together local, national and international participants make it a trusted partner in sustainable development.

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ACRONYMS

B/C	Benefit-Cost
C	Coastal Savannah
CBO	Community Based Organizations
CDM	Clean Development Mechanism
CREMAs	Community Resource Management Areas
DA	District Assembly
EC	Energy Commission
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agricultural Organization
FIP	Forest Investment Plan
FRA	Forest Resource Assessment
FSD	Forest Service Division
FST	Forest-Savannah Transition
GEPC	Ghana Export Promotion Council
GLSS	Ghana Living Standards Survey
GS	Guinea Savannah
HFZ	High Forest Zone
INBAR	International Bamboo And Rattan Network
IRR	Internal Rate of Return
LPG	Liquefied Petroleum Gas
MoFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organization
NPV	Net present Value
NRSP	Natural Resources Support Program
REDD	Reduced Emission from Deforestation and Degradation
SMFEs	Small and Medium Forest Enterprises

UNCOMTRADE United Nations Commercial Trade

EXECUTIVE SUMMARY

The importance of charcoal in satisfying multiple socio-economic needs for income, food security and industrial purposes particularly in sub-Saharan Africa is widely acknowledged. Although charcoal production contributes to deforestation in these countries, development institutions are recently considering the charcoal industry as leverage for addressing poverty and environmental conservation. Tropenbos International Ghana and its partners seek to promote charcoal production as an alternative income source for illegal chainsaw lumber millers in Ghana. In support of this objective, this study assessed the charcoal supply and value chains as well as the economics of production methods and challenges in the industry in Ghana. Further, the feasibility of the switch from illegal chainsaw lumber milling to the charcoal industry, resource implications and potential challenges have been investigated to inform decisions for any such reforms.

Both quantitative and qualitative data were collected from actors involved in charcoal production, marketing and consumption as well as illegal chainsaw lumbering actors in six districts in the transition, forest and coastal zones of Ghana and analyzed descriptively and quantitatively. The study revealed that charcoal is produced throughout the major ecological zones of Ghana but predominantly in the Guinea savannah, transition and forest zones. Production is largely by the earth mound method, although earth brick and metal kilns are used but on limited scale. Wood for charcoal is largely collected from natural standing trees on farms, fallows, forests and thickets as well as stakes from yam farms particularly in the transition and savannah zones. *Anogeissus leiocarpus* (kane) is the favourite species for charcoal for its slow burning properties. Production from *Cassia siamea* woodlots and other species is also on limited scale. A greater proportion of the production (80%) is transported to markets in Accra and Kumasi for subsequent wholesaling and retailing to households, service industries and schools. Some quantity is also exported to Europe and the Middle East.

The charcoal supply and value chains were clearly illustrated, comprising wood resource owners, producers, agents/middlemen, transporters, wholesalers, retailers and consumers. The price spread between the producer gate and the retailer is 60% with the wholesaler earning the highest profit margin of 16.7% in the value chain. Charcoal production is profitable irrespective of method and wood source. Profitability is marginal if wood is paid for yielding positive Net

Present Values (NPV) but marginal Benefit-Cost Ratios (BCR) of 1.1, 1.3 and 1.1 for the earth mound, brick and metal kilns respectively. However, the metal kiln may be the best option for charcoal burning as it yields the highest NPV of GH¢14, 000 compared with GH¢2,400 and GH¢5,800 for the earth mound and brick kiln methods respectively at a real/market interest rate of 22% for forestry projects in Ghana. Also, although the metal kiln requires a substantial initial invest capital of at least $1000, it is movable and has the least labour to total production cost of 27% compared with 60% and 37% for the earth mound and brick kiln methods respectively.

Charcoal industry actors reported that the wood resource base for charcoal production is consistently declining reducing potential supplies to meet the ever increasing demand. Also, the majority of chainsaw actors are willing to switch to charcoal production but caution on its laboriousness and limited wood resources available to sustain the industry in their communities. They suggested a parallel program for the establishment of woodlots of cassia, neem and teak to support charcoal production.

A rotational woodlot system is proposed to ensure sustainable supply of wood for charcoal burning. Approximately 16-20ha woodlot planted in 4ha blocks sequentially over 4-5 consecutive years is needed for a full time producer operating a kiln capacity of 1.22 meters deep, using the brick kiln to burn charcoal throughout the year. The B/C ratios show that although production from plantation is profitable, it is quite marginal at the market lending rate of 22% for the brick and metal kilns with wood from cassia and eucalyptus woodlots respectively.

A program to support sustainable charcoal production among displaced chainsaw millers may need to consider the use of the metal kiln for burning charcoal to save labour. Cassia woodlots may be ideal as a fast growing wood source for production. The program would need to support beneficiaries with loans at lower interest rates of at least 10% as suggested by the World Bank for agricultural projects to enhance profitability. This may especially be so for forestry projects that contributes to environmental conservation for the welfare of the public and economy at large.

1 BACKGROUND

1.1 Introduction

Generally, about sixty percent of the world's total wood removed from forests and outside forests are used for energy purposes. Wood fuels account for about seventy percent of total primary energy supply and about sixty percent of the final energy demand (Trossero, 2002). In developing countries eighty percent of wood produced are used for energy purpose while the developed countries use only thirty percent for the same purpose (Energy Commission, 2003).

The major source of cooking energy used by most households in rural and urban communities in developing countries is fuel wood and charcoal. Globally, there is a positive relationship between growth in population and rate of charcoal use in many developing regions of the world (Broadhead *et al.* 2001). A report by the FAO (2000) on the energy requirements of developing nation's indicated that wood fuel and its derivative (charcoal) supply about 95 percent of the domestic and commercial cooking energy needs in these countries. The demand for charcoal and fuel wood is expected to increase by 30 percent over decade (i.e. 15.9 million m^3 to 20.67 million m^3).

In Ghana, like in other parts of Africa, wood fuel provides 71% of the total annual energy demand (Mason, 2008). Generally, wood fuel in the form of firewood and charcoal is the predominant energy source for industrial, commercial and household uses. In 2010, the Energy Commission of Ghana reported that household and commercial sector energy consumption from fuel wood was 60%. This consumption is expected to double by 2016 (Energy Commission, 2010). While firewood is the major fuel/energy source for rural households; charcoal is used by over 50% of urban households for cooking (Table 1 (Ghana Statistical Service, 2006)). The demand for charcoal is high despite the introduction of alternative sources of energy such as LPG and extension of the national hydro electric grid to many communities. There is also demand for charcoal for export particularly to Europe and recently to the Middle East from Ghana.

Being the predominant source of energy for heating and cooking, fuel wood and charcoal play a key role in food security and significantly support both

urban and rural livelihoods. According to FAO (2000) more than 2.2 million families depend on fuel wood or charcoal for cooking and heating, and at least 280,000 of them use it for small-scale processing activities, thus making a significant contribution to food preservation, food security and cash earnings for rural and urban people. In addition, there are also about 600, 000 small-scale enterprises in commercial activities, such as chop bars and street food vendors, which depend on fuel wood or charcoal as their main source of energy (Broadhead *et al*, 2001).

Table 1: *Households by locality and use by basic utilities in Ghana*

Source of Cooking Fuel	Urban Areas (%)			Rural Areas (%)				Ghana (%)
	Accra	Other						
	GAMA	Urban	All	Coastal	Forest	Savan-nah	All	
None, No cooking	9.2	6.2	7.2	3.6	2.4	0.9	2.2	4.4
Wood	1.0	27.2	18.5	70.5	83.2	82.3	80.2	53.5
Charcoal	52.0	52.9	52.6	23.3	12.3	9.5	13.8	30.6
Gas	34.5	12.8	20.0	2.0	1.9	0.6	1.5	9.5
Electricity	1.1	0.2	0.5	0.1	0.1	0.1	0.1	0.3
Kerosene	2.2	0.7	1.2	0.5	0.1	0.1	0.2	0.6
Crop residue/ Sawdust	0.0	0.0	0.0	0.0	0.0	6.5	2.0	1.1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: GLSS5, 2008

Despite its significant contribution to household welfare and national economies, charcoal production is acknowledged as one of the key drivers of deforestation. In Ghana, charcoal consumption involves numerous end-users who make frequent purchases in small quantities, without much concern for the economic and environmental impacts of their consumption. The United Nations Food and Agricultural Organization (FAO) estimate that 11.3 million hectares of forests are lost annually to agriculture, commercial timber harvesting and uncontrolled fuel wood production and consumption

in developing countries. Unfortunately, 90 percent of cleared forest are never replanted (FAO, 2000). Large quantities of forest residues are destroyed as a result of charcoal production (Makhabane, 2002). With increasing demand for fuel wood Ghana's forest is under threat to deforestation. Ghana has lost close to 70 percent of its wildlife and about 75 percent of its 8.2 million hectares of forest (Resource Watch Agenda, 2010). The over reliance on woody biomass as household and industrial energy in the country, has contributed significantly to the accelerating rate of natural forest depletion particularly in the forest-savannah transition zone. It is estimated that, between 1990 and 2010, Ghana lost almost 34 percent of its forest cover, representing about 2.5 million hectares at an annual deforestation rate of approximately 2% (FRA, 2010).

In addition to the high demand, charcoal production is also regarded as a lucrative livelihood option and major source of supplementary income to rural households in Ghana (ESMAP, 2006), attracting many people into its production. However, suitable tree resources for charcoal production are declining in main charcoal producing areas (Obiri and Nutakor, 2011; Ghana Energy Commission, 2010). Producers are exploiting new species that are less suitable for charcoal, thus using existing traditional conversion methods; poor quality charcoal with perhaps lower calorific value is being produced. This requires more wood to be converted as consumers require higher amounts to satisfy their energy needs from charcoal with poor calorific values worsening the ever increasing demand for wood for charcoal.

Charcoal production is being considered by some development practitioners as a more sustainable forest based enterprise in recent times. This is because appropriate species can be produced in woodlots in shorter rotation systems for conversion. It is believed that this, combined with improved conversion technologies and stoves, can arrest environmental degradation, sustain energy needs and livelihoods in a more acceptable manner. In Ghana, Riçerca Cooperazione (2011) is of the view that charcoal production in the country can be transformed to serve as one of the best strategies to curb the desertification process while alleviating poverty particularly in predominant charcoal producing areas including the Afram Plains. The Government of Ghana has called for prudent management of the country's the wood fuel resources to ensure their efficient use and preservation. This would be attained by ensuring improved productivity, efficiency in transformation and distribution as well as promotion of improved end-use devices and best practices (Pabi and Morgan, 2002).

This study is based on the premise that charcoal production and marketing can be considered an option to illegal chainsaw milling in the country. This is because, illegal chainsaw although a lucrative alternative income to agriculture or farming in forest communities, is not sustainable and also contributes to revenue loss to the state. Tropenbos International, Ghana and partners have been involved in designing appropriate policy measures to reduce illegal chainsaw incidence to ensure legal supply of lumber on the domestic and export market from Ghana. Displaced illegal chainsaw producers who cannot meet the requirements of the new policy option for legal lumber supply require to be settled in alternative lucrative income activities. Charcoal production has been identified as one option for achieving this objective. However, there is need for a thorough understanding of the charcoal production system in general, its economics with respect to invest implications, how it compares with illegal chainsaw milling and its feasibility for promotion as an alternative livelihood option chainsaw dependent communities. Understanding these will contribute to guiding the design of appropriate strategies for maintaining environmental sustainability and charcoal production in Ghana.

1.2 **Focus of the research**

This study generally constitutes baseline or assessment of feasibility of charcoal production as a sustainable livelihood option in Ghana. The study findings is to guide Tropenbos International, Ghana and its partners in their quest to promote sustainable charcoal production as an alternative livelihood income particularly among illegal chainsaw prevalent communities in the country. The study focused on answering the following key research questions:

1. How is charcoal production, distribution, marketing and consumption organized in Ghana?
2. What is the structure of the Ghanaian charcoal value chain and who benefits at what point in the chain?
3. How viable is charcoal production using available technologies?
4. How viable is charcoal production from plantation or woodlots?
5. How does income from charcoal production compare with that from illegal chainsaw lumber milling?
6. What are the implications of promoting charcoal production in chainsaw prevalent communities?

Consequently the main objectives of the study were to:

- Build an understanding of the context of the production, distribution and consumption of charcoal in Ghana.
- Assess investment implications or the viability of charcoal production in the country.
- Assess the feasibility of charcoal production in chainsaw dependent communities.

1.3 Study approach, areas surveyed and information analyzed

The study was structured into three main parts covering: a desk study reviewing the sate of knowledge on the policies and governance of wood fuel resources in Ghana; the organization of the production, marketing and consumption of charcoal i.e. the supply chain, as well as gaps in knowledge associated with the charcoal industry in Ghana. The second aspect covered field studies analyzing the charcoal value chain and financial viability of the charcoal enterprise. The third aspect was also a field study focused on the assessment of the perceptions of the prospects of charcoal production in chainsaw prevalent communities (Figure 1).

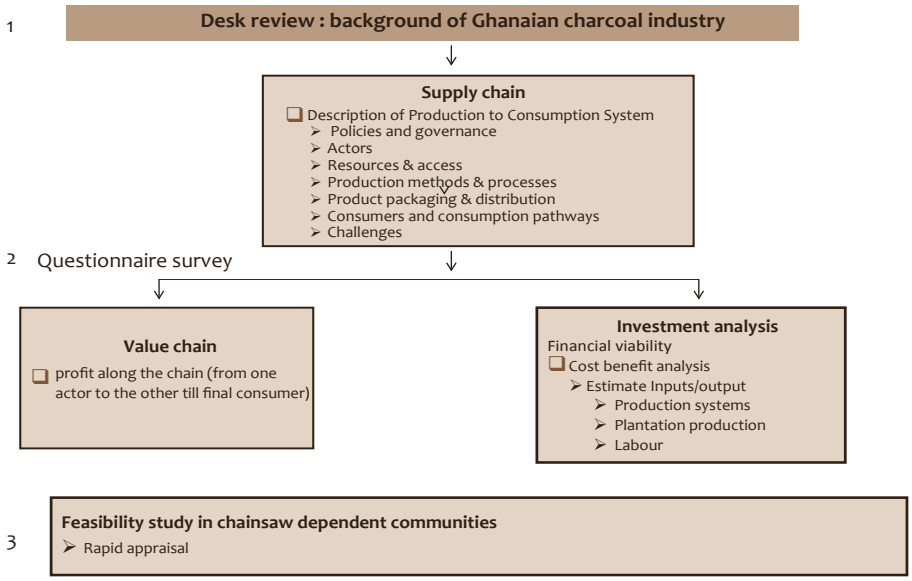

Figure 1: *Schematic presentation of the study strategy.*

The wet, moist and semi-deciduous forest zones?

Charcoal is produced and consumed throughout Ghana. Charcoal production is predominantly undertaken in the Guinea Savannah (GS), Forest-Savannah Transition (FST), Wet, Moist and Semi-deciduous Forest (F) zones as well as in the Coastal Savannah (C) zones. Thus production spreads across the Upper West, Northern, Brong Ahafo, Ashanti, Western, Eastern, Central and Volta Regions. The study covered six districts in six administrative regions in the wet evergreen forest, deciduous forest, forest-savannah transition and the coastal savannah zones of Ghana, (Figure 2). The districts were selected for the study because charcoal is a major economic activity in farming communities in these areas. It was also to capture data on the various technologies used for charcoal production in the country. In addition, Tropenbos International, Ghana has project sites in the Forest zone where it intends to pilot charcoal production as an alternative illegal chainsaw milling.

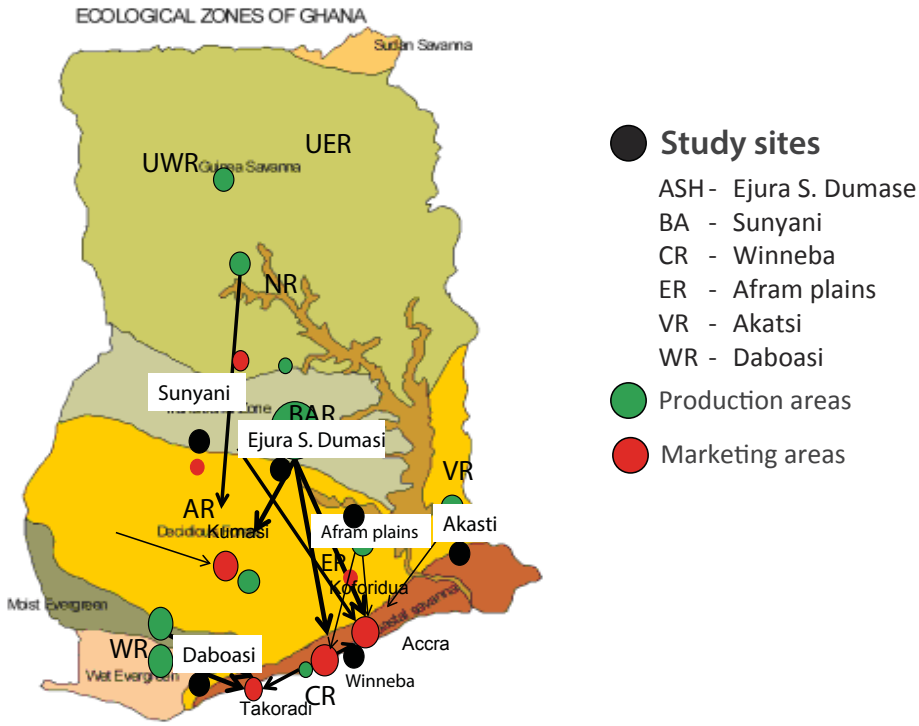

Figure 2: *Map of ecological zones of Ghana, showing study sites*

Both primary and secondary data were gathered for the study. Two sets of primary data were gathered, descriptive data used for narratives for the four segments of the study and economic data for the value chain and investment analysis or financial viability of the charcoal systems (Table 2).

Table 2: *Category of respondent interviewed and data collected*

Respondent category	No. interviewed	Data Type	Location
Traditional earth mound charcoal producer	200	Inputs & outputs, resource access and acquisition, labour, marketing and regulations, socio-demographic profile, etc.	Winneba (Efutu), Daboase (Mpohor Wassa East), Afram plains, Ejura Sekyere Dumase
Earth brick kiln charcoal producer	1 Model commercial producer from FORUM project INBAR bamboo charcoal producer group	Inputs & outputs, resource access and acquisition, labour, marketing and regulations, etc. Plantation production from *Cassia* Inputs & outputs, resource access and acquisition, labour, marketing and regulations, etc. Model production from bamboo in natural stands	Akatsi Daboase (Mpohor Wassa East)
Metal kiln charcoal producer	1 Export producer INBAR bamboo charcoal producer group	Inputs & outputs, resource access and acquisition, labour, marketing and regulations, etc. Plantation production from *Eucalyptus* Model production from bamboo in natural stands	Winneba (Efutu) Daboase (Mpohor Wassa East)
Charcoal transporters/ wholesalers/ distributers/ marketers		Charcoal supply and distribution, costs, sale prices, regulations, socio-demographic profile, etc.	Daboase, Afram plains, Ejura Sekyere Dumase

Respondent category	No. interviewed	Data Type	Location
District authority		Regulations, charcoal taxes, product flows, etc.	Afram plains, Ejura Sekyere Dumase
Forest officers/ technicians/ guards	4	Charcoal production sites, etc.	Akatsi/Denu, Daboase, Afram plains, Ejura Sekyere Dumase

1.4 Organization of the report

This report is organized into seven chapters. Chapter One is on the background to the study. Chapter Two is a review of literature describing the charcoal supply chain in Ghana elaborating on the production-to-consumption system in Ghana and other parts of Africa. Chapter Three describes the charcoal value chain in Ghana, while Chapter Four entails the assessment of the financial viability of three charcoal production technologies/methods in use in Ghana. Chainsaw actors' perceptions of the feasibility of charcoal production as an alternative income source to illegal chainsaw milling are presented in Chapter Five. Chapter Six is a synthesis reflecting on the major issues from the other chapters as well as conclusions and recommendations while Chapter 7 enumerates further research that needs to be accomplished to complement findings reported in this study.

2 CHARCOAL PRODUCTION-TO-CONSUMPTION IN GHANA: A REVIEW

Summary

This chapter largely, covers a state of the art review of literature on the charcoal industry in Ghana. Charcoal is produced in all regions of the country with the bulk of the production for urban supply from the savannah and transition zones of the Brong Ahafo, Eastern and Northern Regions. The charcoal supply chain is well developed and characterized by traditional charcoal production from forests, fallows and farmlands by predominantly male producers around the country but mainly in rural areas of the savannah and transition zones of the country. The product is distributed by middlemen made up of truck dealers and traders in sacks of average 40/50kg to whole sale depots and retail markets as well table tops around homes at urban centres and towns. However, actors in the chain are not properly organized into associations. Likewise their activities are also not largely regulated and monitored.

The Energy Commission has drafted a wood fuel policy for Ghana that seeks to develop and regulate production of wood fuel raw material, processing technologies, transportation/distribution and marketing of wood fuel products as well as the strengthening of institutional and regulatory arrangements. Although the policy provides a suitable investment climate in the wood fuel sub-sector, it does not emphasize strategies for development of the related enterprises based on sustainable business models.

According to Ghanaian forest laws, trees in the forest reserves and some plant species are not permitted to be felled as wood fuel except under a special permit issued by the Chief Conservator of Forest with the approval by of the Forestry Commission. Although violating this regulation is punishable, some persons flout this regulation and may be apprehended by officials of the Forest Services Division when discovered. Generally, indiscriminate cutting of tree species for charcoal in both reserved and off reserved forests areas has resulted in unfavourable ecological consequences particularly in the savannah areas of the country. Although charcoal production is destructive to the natural environment the financial returns charcoal producers gain from their activities has been the driving force in the face of limited viable job opportunities in rural areas. This threatens the future of the remaining wood fuel resources in the country as production occurs

throughout the country without any regulation and concrete actions to manage wood fuel resources. Further there is no empirical data on available stocks to guide policy and sustainable management, although Riçerca Cooperazione (2011) provides some estimates from TEU (2004)1. Also there are no reliable data on the magnitude of annual charcoal production around the country. Most District and Metropolitan Assemblies collect levies from charcoal traders and trucks at the production sites and markets but hardly take records on the magnitude of flow from production areas and into markets.

There are a number of studies on fuelwood and charcoal but no targeted interventions underway in Ghana. The traditional earth mound technology is still largely used in commercial charcoal production. The Sissala traditional production method or carbonization process with 20% efficiency of conversion of wood is probably the most efficient production technology. Despite earlier attempts to introduce improved or more efficient kilns that ensure higher efficiency in the conversion of wood into charcoal, these modern kilns have rather been adopted on a limited scale because of the investment implications for the promoters and the numerous small commercial producers in the enterprise.

Scarcity of appropriate wood species for charcoal making is reported in charcoal producing areas. Alternative species are being used to supply poor quality charcoal that result in heaps of charcoal dusts on markets. Charcoal from such species also burns quickly with increased production of ash.

Pragmatic and holistic measures are required to sustainably exploit the potential of charcoal production for poverty alleviation and environmental conservation. Namaalwa et al., (2009) analyzing a bio-economic model for charcoal production in Uganda predicts that combining technological advances and regulatory interventions may lead to more sustainable charcoal supply. In Ghana this will certainly require the development of raw material base, efficient processing technologies, organization and regulation of production and marketing chains and a strong policy commitment to support these processes.

2.1 Introduction

Charcoal and firewood production and marketing have been age-old forest based income earning activities in most parts of the developing world for subsistence and commercial purposes. In the developed nations, industrial

1 TEU Completion Report 2004

charcoal enterprises are reported (FAO 1985). Thus the literature is replete with information on the charcoal industry. The organization of the charcoal industry including production methods/technologies, resource implications among others is generally reported (example, FAO 1985, Leach and Mearns 1987, Makhabane 2002, Kammen and Lew 2005, GTZ/Marge, 2008). In Ghana there is considerable narrative information on the charcoal industry (FAO 1985, Monela *et al.,* 1993, Bank of Ghana 2004, Brown and Amanor 2006, Blay *et al.*, 2007, Mason, 2008, Lurimuah 2011, Riçerca Cooperazione, 2011, Brefo *et al*. 2012). This needs to be synthesized to serve as background knowledge and a guide to further studies required for addressing the challenges of the industry as well as its promotion for poverty alleviation in the country.

This chapter is based on a desk study reviewing both local and international literature/knowledge on the charcoal supply chain specifically focused on the following:

- Wood fuel resource governance and inter-sectoral policies;
- The structure, function and organization of the production-to-consumption system for charcoal including:
    - Profile of actors, sources and access to raw materials, production technologies and processes, distribution networks, marketing and consumption pathways/ flows as well as challenges constraining production, marketing and consumption.
- The impact of charcoal production on the environment,
- Gaps in knowledge and recommendation on measures that must be addressed to enhance the sustainability of the industry.

2.2 Wood fuel resource governance in Ghana

2.2.1 Sector policies on wood fuel and charcoal

Despite the economic benefits derived from charcoal production and associated threat to the environment, little attention has been paid to the manner in which charcoal is produced and sold in the developing world, due to the lack of coherent policies. Charcoal production, transportation and distribution remain informal and unregulated therefore rendering them inefficient and risky (World Resource Institute, 2005).

In Ghana generally, numerous policies and programs such as the draft wood fuel policy on renewable energy, REDD+, Forest Investment Plan (FIP), domestic timber market policy, decentralisation policy, wildfire management policy among others related to the forest sector have not adequately paid due recognition to exploiting the potential of Small and Medium Forest Enterprises (SMFEs) for socio-economic development in the country. Thus, although, national land use policies acknowledge the sustainability and effective utilization of wood resources, there have not been any concerted efforts to develop and manage forest resources for wood fuel purposes, neither has there been adequate attention paid to programs for the development and regulation of the associated firewood and charcoal enterprises. Component 3 of the Forest Investment Plan is focused on sustainable woodfuel production in the savannah transition zone. This seeks to ensure the following:

- Support options for increased efficiency in charcoal production
- Support sustainable fuelwood harvesting and fuelwood production systems to produce emissions reductions/removals and other benefits, (potentially including investment in woodlots, establishment/engagement with CREMAs, charcoal producer "guilds" and community land use and natural resource planning)
- Leverage co-financing and private sector investment in woodfuel plantations

Nevertheless, Riçerca Cooperazione (2011), reports that there are generally inadequate local policies and regulations to manage natural resources as well as support its rehabilitation in the country. Likewise, local communities do not possess the requisite capabilities to manage natural resources which possibly contribute to low sustainability of economic activities in rural communities. Studies conducted in the past on fuel wood and charcoal in Ghana to guide policy decisions have not been adequately utilized, thus there has been limited interventions and actual implementation of recommendations in the country. This makes it difficult to regulate activities within the industry, hence the incidence of severe pressure on both the natural environment and the biodiversity (Energy Commission, 2010).

In 2010, the Energy Commission of Ghana developed a draft bio-energy policy with sections on the development of the wood fuel sub-sector. The objective of the wood fuel policy is to promote and ensure sound management as well as expansion of the country's natural forest for sustainable supply of wood fuel. The key challenges to be addressed by the policy include:

- Sustainability of sources of supply
- Production of efficient technologies for wood fuel production and use
- Substitution of traditional wood fuels with more modern fuels like LPG
- Efficiency in the transportation of wood fuel
- Improved packaging and marketing
- Strong coordination in institutional and regulatory arrangements

The key strategies for addressing these challenges are as follows:

1. ***Feed stocks development &management***

This is aimed at sustainable production and supply of wood fuel resources/raw material through efficient management of natural forest stands and expansion through woodlots

Policy strategies

- Prepare an inventory of wood fuel resources in Ghana
- Identify, survey, map, assess and register the potential wood fuel resource stock outside the forest reserves in collaboration with Traditional Authorities (TAs), District Assemblies (DAs) and Forest Service Division (FSD)
- Support FSD and Agricultural Extension Units of Ministry of Food and Agriculture to create awareness on the need for sustainable supply, production and utilisation of wood fuel
- Support Non-Governmental Organisations (NGOs) and Community-Based Organisations (CBOs) to create awareness for the development and management of suitable wood fuel species
- Encourage timber concessionaires to utilise forest and sawmill off-cuts for wood fuel production
- Collaborate with FSD to enforce regulations on the control of fringe communities in the harvesting and sale of the wood fuel in the forest reserve
- Enact legislation to register and licence all commercial wood fuel operators (suppliers, producers and sellers) by the DA and FSD to be given exclusive trading rights;

- Establish standards and operational procedures for wood fuel operators; (noncompliance to these would attract the necessary sanctions)
- Create, develop and maintain a data bank and resource documentation centre for wood fuel at district (DAs / FSDs), regional and national levels.
- Identify and provide incentives (financial and non-financial) for the development of woodlots in savannah and transitional zones under international funding protocols such as the Desertification Fund and Clean Development Mechanism (CDM) Fund
- The DAs should liaise with traditional authorities to educate and release land to prospective individuals (especially women) and groups for wood fuel woodlots and plantation establishment.

2. ***Efficient production/processing technology***

This is aimed at improving charcoal production efficiency to increase charcoal yields through the introduction of new and innovative ways of producing wood fuel more efficiently and cost effectively

Policy strategies:

- Energy Commission to provide technical assistance and funding for programmes to transfer improved carbonization technologies and higher levels of efficiency in the production, distribution and use of wood fuel
- Strengthen through technical assistance existing institutions for testing and certification of improved production and end use technologies for wood fuel
- Provide logistical support for the Agricultural Extension Officers to expand technical assistance and the creation of awareness on the adoption of improved carbonization technologies to charcoal producers

3. ***Efficient end-use technology***

The traditional wood fuel stoves have low efficiencies and as well generate a lot of smoke in the cooking environment which leads to health hazards, especially respiratory diseases. Even though the improved stove is about 20 percent more expensive than the traditional stoves, the expected savings on fuel cost is said to be significant to pay off on the investment of the improved stoves. The policy on end use technology focuses on promoting the adoption

of more efficient wood fuel but less expensive cook stoves and build capacity of improved cook-stoves manufacturers.

Policy Strategies

- Liaise and coordinate with relevant governmental and non-governmental agencies to train artisans in the production of improved stoves
- License or register commercial charcoal producers to enable the EC to support them to adopt improved production technologies
- Create public awareness on energy efficiency and conservation practices and health impacts (especially on women) in the use of wood fuel

4. ***Safe and efficient transportation & marketing***

Even though wood fuel is an inflammable energy product there is no fire precautionary measure in place for bulk marketing and transportation.

- To develop a comprehensive database for wood fuel supply and demand
- To minimise charcoal dust creation, environmental and health impacts
- To control fire outbreaks in the production and handling of charcoal

Policy Strategies

- Enact LIs and bye laws for the recycle or compacting of charcoal dust into briquettes, etc.
- Create awareness on health impacts of inhaling charcoal dust and other particulate matter and promote the use of protective mask for commercial handling of charcoal.
- Enact Legislative Instruments (LI's) and bye laws for improved packaging and labelling of charcoal.
- Enforce safety regulations in the production, transportation and marketing of charcoal.

5. ***Strengthening Institutional linkages for better governance***

The aim is to strengthen institutional linkages for improved wood fuel resource governance. The key/primary institutions associated with the wood fuel sub-sector include the following:

1. Forestry Commission, Traditional Authorities and District Assembly (control access to raw material, processing and conveyance at the forest gate),
2. Police and Customs Officials at check points (control conveyance en-route to market) 3. District and Metropolitan Assembles (tax and revenue collection on local, district and regional markets)
4. Transporters/middlemen (distribution)
5. Market associations (regulation and distribution on markets)
6. Energy Commission (regulate and manage energy needs of the country)

Woody material used in charcoal production is sourced from public and private forest lands in both reserved and off-reserve areas. While the management of reserved forests is strictly under the jurisdiction of the Forestry Commission, the management of forests in the off-reserve areas is by traditional land owning authorities and private landowners. The forestry commission has responsibility for monitoring and enforcing rules related to charcoal production on private lands, and plays a large role in regulating the transport of charcoal beyond boundaries of every district. Taxes are collected at various stages in the value chain. Officially, the FC issues a permit at a fee for the collection of NTFP's including poles for charcoal production from reserved forest areas for commercial purposes. The conveyance of charcoal beyond the boundaries of production areas is also taxed by the District Assembly at the forest gate on issuing of a waybill. Police and Customs officials at various check points and borders check waybills to ensure the authenticity of source of products during transportation on the road en-route. Local district and metropolitan assemblies also collect tolls/levies on respective markets as well as at the retailing points.

By the Act of Parliament (Act 541, 1997) the Energy Commission was established and given the statutory mandate to manage and regulate the utilization of energy resources in Ghana. The commission is considering measures to recommend policies to the Government for efficient and cost-effective utilization of the wood fuel resource. The commission would therefore need to update and reorganize the existing wood fuel data for the development of sustainable wood fuel policies. The charcoal stakeholders officially outlined to work coherently in the attainment of broad objective of efficient and cost-effective utilization of the wood fuel resource and associated value chain include:

- Ministries of Energy Lands and Natural Resources

- Ministry of Environment, Science and Technology
- Ministry of Employment and Social Welfare,
- Ministry of Trade and Industry
- Energy commission
- Charcoal producers (small scale and export)
- Environmental Protection Agency
- Middlemen
- Charcoal sellers including exporters, the
- Ghana Export Promotion council and identifiable consumers, e.g. hotels, restaurants, chop bars. Other relevant stakeholders are the
- Rural Enterprises Development Programme and other rural business advisory firms,
- Rural banks and Micro financing institutions
- Intermediate Technology Centre and relevant informal fabricators from the Kumasi Magazine

2.2.2 Tenure/rights and access to wood fuel resources

Land tenure is a key source of conflicts in controlling and regulating natural resources consumption. The type of access right to wood resources for firewood or charcoal in Ghana primarily depends on whether the resource is located in designated on-reserve or off-reserve forest areas. Traditionally, all forest lands were owned in common by communities (families, clans and 'stools) in the pre-colonial era. Parts of these forests were reserved by The Forest Ordinance of 1927 by which forest land are still owned by traditional authorities but held in trust and managed by the government for these land owners (Acheampong and Marfo, 2011). All forest lands outside reserved forest areas are termed to be in the off-reserve.

On-reserve access

A larger percentage of wood fuel is collected from farms and fallow lands but also from natural forest stands whether in the on or off-reserve (Obiri *et al*., 2012). By the Forest Ordinance of 1927, all forest products within reserved forests, including both timber and non-timber tree species and products are vested in the government. As a result, traditional owners have no right of access

to the trees in reserved forests, except on permit from the Forest Services Division (FSD) (Acheampong and Marfo, 2011). Thus on-reserve access to wood fuel for commercial purposes is regulated by the Forest Services Division of the Forestry Commission through the permit system. Access is granted to the collector on acquisition of a permit at a fee for a specified period. Material types that may be permitted for collection/harvesting include:

- Dead wood
- Logging residue
- Deformed plantation material and residue
- Species of no timber value harvested with special permit from the Forestry Commission

According to Ghanaian forest laws, trees in the forest reserves and some plant species are not permitted to be felled as wood fuel except under a special permit issued by the Chief Conservator of Forest with the approval by of the Forestry Commission. A person who contravenes the regulation commits an offence punishable by the law (Amoh-Anguh, 1998). Nonetheless, some persons flout this regulation and are sometimes apprehended and may be fined by officials of the Forest Services Division, of the Forestry Commission.

However, Riçerca Cooperazione (2011) reports that in practice, exploitation of non-timber forest products under which wood fuel (firewood and charcoal) are classified are largely unregulated. Thus wood fuel resources are often regarded as "free common" goods that can be collected at any time anywhere.

Non-commercial collection, usually few pieces of dead wood for household purposes may not require permit. However, in most cases women and children will gather wood fuel for household use from farms or fallows within the off-reserve forest areas.

Off-reserve access

Access to off-reserve wood fuel resources for commercial charcoal production is purely based on informal arrangements with traditional or individual private or family landowners. Different negotiations are made for exploitation rights. For instance Joos *et al*. (Undated) observed that in the transition zone of Ghana small scale occasional charcoal producers who supplement farming by occasional charcoal burning secure wood resources from their own farmlands while large scale producers from the *Sissala* tribe, negotiate with farmers

including landowners to purchase exploitation rights on their farmlands in return for cash or a certain amount of charcoal.

Acheampong and Marfo (2011) indicate that in the High Forest Zone (HFZ) of the country people with the right to use a piece of land in perpetuity also have the right to plant any species of trees, and such trees are vested in the planter/cultivator. Similarly, naturally occurring tree resources on such a person's land if not commercial timber trees, is owned by the person irrespective of gender. Migrants who have acquired long-term title or right to the use of land through an agreement on leasehold basis also have the right to plant and use any species of tree. However, migrants with temporary use of land do not have the right to plant permanent trees on such lands (Acheampong and Marfo 2011 citing Asare, 1986). Although customary laws do not prevent tenants from planting trees, landowners do not encourage this practice. This is because of the long production period associated with trees. Also the lack of appropriate documentation of land ownership generally pertaining in the country increases the security of the tenant to land rights when trees are planted. Thus, most land owners perceive an attempt by a tenant to plant trees as tantamount to permanent ownership of land (Acheampong and Marfo, 2011).

While the FSD officially regulates wood fuel collection from forest reserves, traditional authorities especially in the transition and guinea savannah zones may institute local bye-laws to control/regulate indiscriminate harvesting of certain key wood fuel species such as *Anogeissus leiocarpus* and *Vitellaria paradoxa* to protect them from over exploitation. Under such circumstances only dead stands or trees that have been wind thrown are permitted to be harvested for use as firewood or for conversion to charcoal.

2.3 Charcoal production, marketing and consumption in Ghana

2.3.1 Production and utilization of wood fuel in Ghana

Figure 3 illustrates an overview of the unit operations of a typical wood energy system (FAO, 2003). Charcoal production and distribution also follows a similar system. These systems may differ from country to country, from area to area and from situation to situation. However, they essentially indicates the distribution channels from production sites to end-users involving all the (steps

and/or) unit processes and operations involved in the production, preparation, transportation, marketing, trade and conversion of wood fuels into energy.

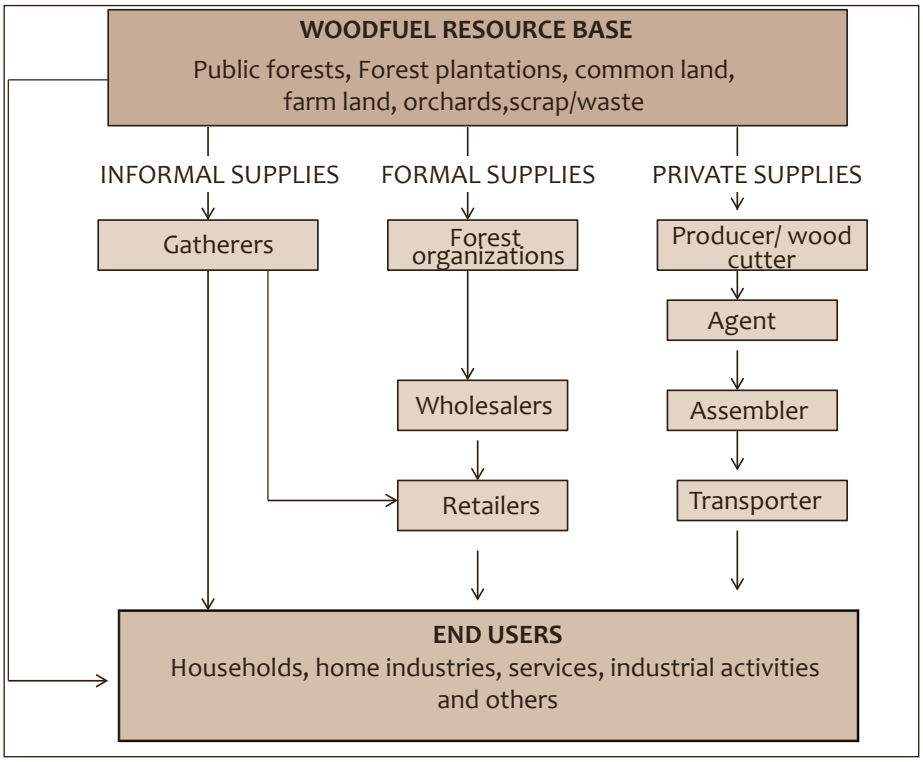

Figure 3: *Wood energy system (FAO, 2003)*

In Ghana the wood fuel supply or production and distribution chain typically consists of feedstock/raw material sources and owners/exploiters, producers, dealers/transporters, bulk sellers, retailers and exporters. Wood fuel products (firewood and charcoal) are mainly produced in rural areas and consumed or used in both rural and urban centres for domestic purposes mainly cooking. Wood fuel is also used for industrial/commercial activities such as bricks and tiles manufacturing, pito (local beer) brewing, pottery production, oil extraction from seed and nuts as well as for fish smoking (Amoh-Anguh, 1998).

2.3.2 The charcoal supply chain

Figure 4, is an overview of the supply chain for charcoal in Ghana. It indicates the sources of raw material and the flow of charcoal through actors in the charcoal supply/production and distribution chain from production to consuming areas and to consumer segments.

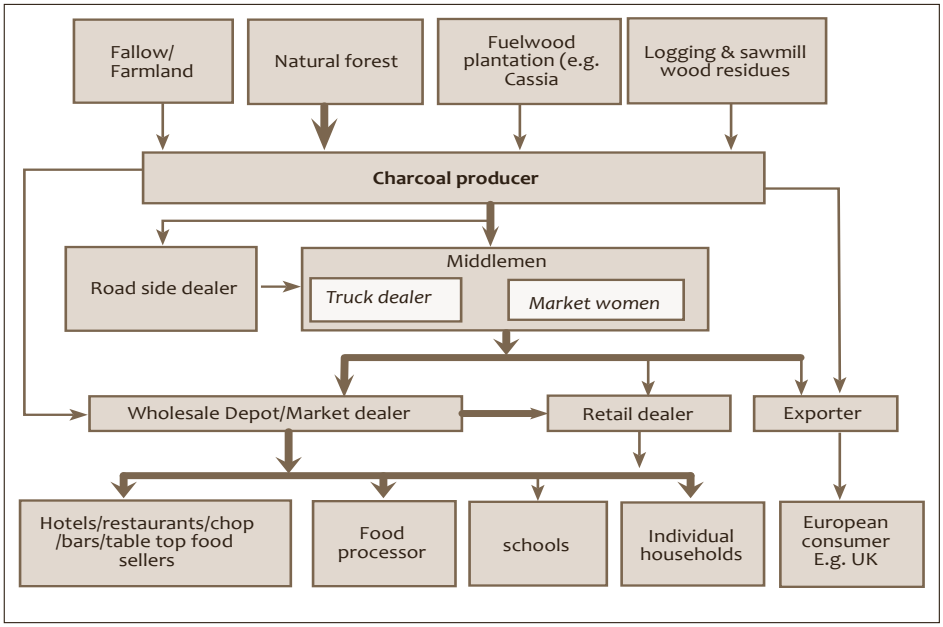

Figure 4: *Charcoal supply chain in Ghana.*

Source: Obiri and Nutakor, 2011

2.3.2.1 Actors and processes in the charcoal supply chain

2.3.2.1.1 Demographic profile of charcoal producers and traders

The approximate number of actors i.e. producers, transporters/distributors and traders in the charcoal commodity supply and marketing chain in the country is not indicated in literature. Charcoal is largely produced by males aged between 20 and 60 years in rural communities in Ghana. Amoh-Anguh (1998) reports of male aged between 35 and 54 years involved in wood fuel and charcoal production in the Upper Denkyira District of Ghana. He however observed that in one of his sample villages (Esikuma) female and children dominated in charcoal production. The women fell trees for charcoal production with the axe or cutlass or engaged men to fell the trees with chainsaws. Blay *et al.,* (2007) report male adults in the age range 30-49 being dominant producers in the Kintampo North and Afram Plains areas in the transition. Lurimuah, 2011 reports that in the savannah zone of the Upper West Region of Ghana the *Sissala's* in their home districts of Sissala East and West are the major commercial charcoal producers in the region. The author observed that traditional charcoal production is labour intensive. Thus, the youth in the age range of 20-49 constituted 73% of commercial charcoal producers sampled

for the study and were predominantly men, with some women also involved in the enterprise. Indeed, *Sissala* women are found in the timber processing areas in the Kumasi Metropolis of the Ashanti region, producing charcoal from sawmill and carpentry wood residues for sale in the capital. Male dominance in charcoal production contradicts observations made by Riçerca Cooperazione (2011) which reports that over 80% of commercial charcoal and firewood producers in Ghana are women. This was attributed to increasing migration of rural men to urban centres for more lucrative employment causing male labour shortages in rural areas of the country.

2.3.2.1 .2 Scale categories of charcoal producers and traders

Charcoal is generally produced by numerous small and medium scale producers either on subsistence or purely commercial basis using traditional technologies. There are very few export oriented producers using improved kilns for charcoal production (Obiri and Nutakor, 2011).

Joos *et al*. (undated) distinguished two types of small scale traditional charcoal producers in Ejura Sekyeduamsi District, one of the dominant charcoal producing areas in the Savannah Transition zone.The first type comprised of farmers who produce charcoal on a rather small scale. These supplement farming by occasional charcoal burning from wood resources on their own farmlands. Capital raised from charcoal is often reinvested in farming (hiring of labour for land clearance and weeding). These producers are mainly migrant farmers from the northern regions of Ghana, where the conditions for farming are less favourable. The second type consisted of large scale traditional producers from the *Sissala* tribe, also from Northern Ghana who are traditionally commercial charcoal producers in Ghana. In the major charcoal producing zones of the country especially in the transition, 80% or more of such producers depend solely on charcoal production for their livelihood (Blay *et al.,* 2007; Brefo *et a*l., 2012).

Riçerca Cooperazione (2011) also distinguished three groups of charcoal producers in the country:

1. Peasant farmers living in rural communities producing charcoal from their farms. The charcoal is conveyed on bikes, donkey carts and head loads to the road side and rural markets for sale. In most cases these producers operate on small scale and build stocks for the buyers.
2. Full time small producers (mostly local farmers) producing charcoal in commercial quantities and conveying the product to urban markets

or stock them at the village level in anticipation of buyers from the urban centres. Production is done on farms where some token fees are paid to land owners for trees used.

3. Commercial charcoal dealers from urban centres who hire 'professional producers' to produce the charcoal for the dealers. These producers usually acquire concessions from land owners, negotiate and pay fees to use tree resources to produce the charcoal at a particular site. After deforesting and degrading an area, they move to other areas endowed with preferred tree species and pitch camp to produce charcoal.

Charcoal traders involved in the haulage/distribution and sale of the product in bulk and retailing operate as small and medium enterprises at two levels. There are traders operating at the subsistence level for income diversification purposes to supplement a major cash income source (farming, paid jobs, etc.) or as a survival strategy for specific or contingent cash needs whereas others operate on full time basis (Riçerca Cooperazione, 2011).

2.3.2.1.3 Production-to-consumption process

Generally, woody material usually in the form poles and pieces of wood is usually sourced from farms and fallow lands, natural forests, plantations and logging and sawmill residues by gatherers who may also be charcoal producers.

After conversion into charcoal the product may be supplied to a roadside dealer (usually based in production areas), truck dealers or market women (Mason, 2008). The truck dealers and market women are essentially middlemen who are the main distributors. These supply depot or wholesale markets and sometimes retail dealers in urban charcoal markets. In the local market places for charcoal in Ghana, there is bulk and retail sale dedicated areas with 4 key consumer segments. These include Schools, individual households, food processors and food vendors in the hotels, restaurants, chop bars and table top food vendors on streets, around home areas and on markets (Figure 2). Direct supply from producer to the seller at charcoal depots or individual sale points in the urban areas also prevails. Middlemen may supply or sometimes producers deliver directly to exporters. Export production goes to the European markets mainly the United Kingdom, Belgium, Italy, Netherlands and Germany.

At the production or collection point in the village, an FSD official is to check for the authenticity of the source of the wood before conveyance to the market but it is not certain if this is done. However, the transporter may pay for a waybill to the District Assembly at the loading point in the village to permit

conveyance to market. While on the highway, en-route to market the product is checked by customs or police officers at check points with the country and cross the borders overland to neighbouring countries.

2.3.2.1.4 Charcoal producing and consumption areas

Charcoal is produced across all the major ecological zones of Ghana. However, the main centres are in the Forest Savannah Transition in the middle belt, the Guinea Savannah and Coastal Zones as well as in the High Forest Zone. The major producing regions are the Northern, Brong Ahafo, Western, Eastern, Ashanti and Volta Regions (Figure 5). Corresponding districts and towns or areas in the regions are presented in Table 3.

Similarly, charcoal is marketed on all urban and on some rural markets in all regions across the country. The major urban markets are in Accra, Kasoa, Kumasi, Takoradi and Tamale (Figure 6).

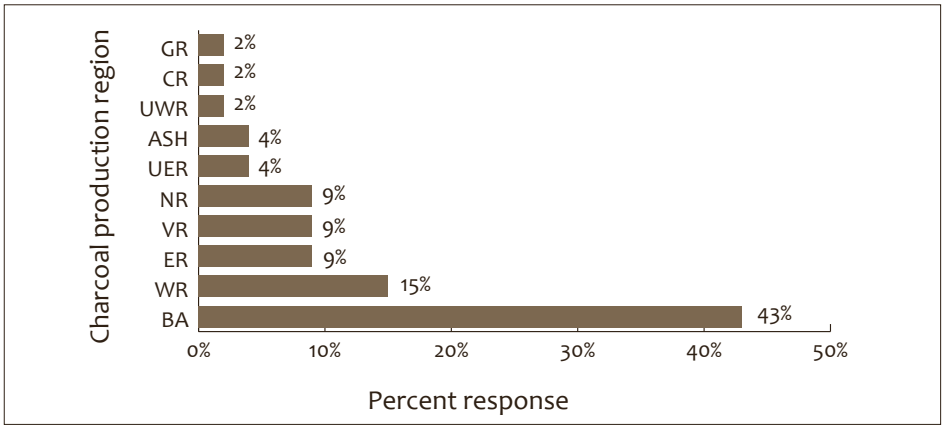

Figure 5: *Charcoal production regions/ supply sources.*

Source: Obiri and Nutakor 2011

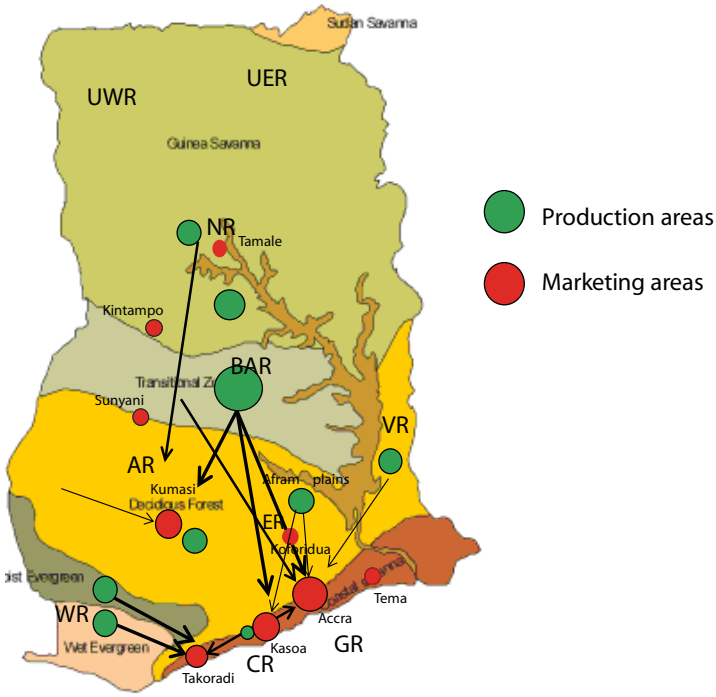

Figure 6: *Ecological map of Ghana showing main charcoal production & marketing areas*

Source: Obiri and Nutakor, 2011

Table 3: *Some charcoal producing areas in the regions*

Region	Charcoal producing areas
Ashanti	Ejura, Mampong
Brong Ahafo	Atebubu, Kintampo, Meawani, Apesika, Wenchi, Techiman
Central	Winneba
Eastern	Afram plains, Akosombo, Gemani,
Western	Axim, Elubo, Mile 9, Tarkwa, Daboase
Volta	Akatsi
Northern	Bupe, Yeji, Bole-bamboi, Salaga
Upper West	Wa East, Sissala East, Sissala West

Source: Obiri and Nutakor 2011; Lurimuah, 2011; Blay *et al.*, 2007

2.3.3 Wood fuel raw material supply

2.3.3.1 Sources of wood for charcoal production

In Ghana, wood for charcoal production is usually obtained from the natural vegetation as well as from land clearing for farming, especially in the yam production systems in the forest-savanna transition. In some areas in the Kintampo North District wood for charcoal production is from stakes disposed from yam production (Brefo *et al*., 2012 and Amanor *et al*., 2005). Some production is from *Senna siamea* woodlots in the coastal areas of the Central and Volta Regions and other privately owned plantations targeted for export production (GEPC, 2003). Production from logging residues and sawmilling wastes also prevails in forest areas as well as urban centres where sawmilling activities are common, example Kumasi (Figure 2) (Obiri and Nutakor, 2011). The use of bamboo for charcoal production has recently been introduced among small scale producers (INBAR, 2012).

According to Riçerca Cooperazione (2011), the main source of wood fuel is from the savannah ecosystems. Charcoal producers are supplied from three main sources namely:

1. Wood surpluses from felling to clear new agricultural lands including rotational fallow systems
2. Fallen, dead branches and twigs picked off the ground
3. Harvesting of live trees directly for fuel either intensively (clear felling) or extensively (some form of selective harvesting) from uncultivated areas.

2.3.3.2 Charcoal species

Charcoal can be made from both hardwood and softwood species. The wood species for charcoal are classified into soft and hard based on their period it takes to be converted into ashes. However, hardwood species are usually preferred because charcoal from such species has higher energy content, burns slowly over longer periods and often leaves less ash residue and dust. Some traditional charcoal species are listed in Table 4 (Brefo *et al.,* 2012; Obiri and Nutakor, 2011, Lurimuah 2011; Blay *et al*., 2007; Amanor *et al*., 2005; Amoh-Anguh, 1998 and Joos, *et al*., undated,). The most preferred traditional species used for charcoal production in the country include *Anogeissus leiocarpus* (kane), *Vitellaria paradoxa* (nkrakudua), *Terminalia avicenioides* (ongo). These

and others such as *Milicia excelsa* (odum), *Nesigordina papaverifera* (danta), *Piptadeniastrum africanum* (dahoma) and *Khaya spp*. (mahogany) are economic red hard wood species that are also desirable for timber and are not readily available in natural forest stands (Table 4). Most the tree species are economic trees that are valued by rural people for their fruits, wood, medicinal properties or their fuelwood and charcoal properties (Amanor, et al, 2005). In Tanzania, Monela *et al,* (1993) identified tree species of the genera *Terminalia, Combretum, Brachystegia* and *Dalbergia* as sources of high quality charcoal.

Table 4: *Some tree species used for charcoal production in Ghana*

No	Local name	Scientific name	Characteristics	Other uses
1	Kane/Sekadua	*Anogeissus leiocarpus*	Hard	Medicine, construction
2	Krankudua	*Vitellaria paradoxa*	Hard	-
3	Petepreh	-	Hard	-
4	Odum	*Milicia excelsa*	Hard	Medicine, construction, furniture
5	Danta	*Nesigordina papaverifera*	Hard	Medicine, chew stick, construction
6	Kaku	*Lophira alata*	Hard	Construction
7	Potrodom	*Erythrophhleum ivorense/ guineensis*	Hard	Medicine, construction, furniture
8	Mahogany	*Khaya spp*	Hard	Medicine, construction, furniture
9	Dahoma	*Piptadeniastrum africanum*	Hard	Medicine, construction, furniture
10	Neem	*Azadirachta indica*	Hard	Medicine, furniture
11	Nkontan	*Uapaca guineensis*	-	-
12	Watapupuo	*Cola gigantea*	-	Medicine, furniture
13	Aportrode	-	-	-
14	Brenkraku	-	-	-

No	Local name	Scientific name	Characteristics	Other uses
15	Esia	*Petersianthus macrocarpus*	-	-
16	Hacho		-	-
17	Krayie	*Pterocarpus erinaceus*	Hard	Ornamental, forage, firewood, timber medicine
18	Kusia	*Nauclea diderrichii*	Hard	Medicine, furniture
19	Mango	*Mangifera indica*		Medicine
20	Nkachia	-	-	-
21	Nkashie	-	-	-
22	Odwendwenaa/ Odwe	*Baphia nitida*	Hard	Medicine, tool handles
23	Pinimi	*Radophyllum caloph*	-	-
24	Adankompaboa	-	Hard	Medicine, furniture
25	Wudua	-	-	-
26	Kako	*Drepanocarpus lunatos*	-	-
27	Daniella	*Daniella spp*		
28	Senya			Drum
29	Prekese			Medicine, food-condiment
30		*Afzelia africana*		Stake, lumber, firewood, drum
31	Adankopaboa			Medicine
32		*Detarium microcarpum*		Food, firewood, lumber
33		*Burkea africana*		Fodder, stake, lumber, firewood, medicine
34	Ongo	*Terminalia avicenioides*		

No	Local name	Scientific name	Characteristics	Other uses
35	Denya	*Cylicodiscus gabonensis*		
36	Nyamedua	*Alstonia boonei*		
37	Otennuro	*Trichilia manadelpha*		
38	Kakapenpen	*Rauvolfia vomitoria*		Medicine
39	Esa kokoo	*Celtis Zen Keri*		
40	Kokrodua	*Pericopsis elata*		Lumber
41		*Pericopsis latifolia*		
42		*Terminalia macroptera*		Firewood, timber, medicine
43		*Phyllanthus discoides*		
44		*Manilkara multinervis*		
45		*Cassia sieberiana*		Timber, medicine, firewood, ornamental, fibre
46		*Hymenocardia laxiflora*		
47		*Pseudocedrela kotschi*		
48		*Lophira lanceolata*		
49		*Lannea acida*		Forage, timber

Source: Amoh-Angoh, 1998; Amanor *et al*., 2005; Blay *et al*., 2007; Obiri and Nutakor 2011; Lurimuah, 2011; Brefo *et al*., 2012; Joos, *et al*., undated.

2.3.3.3 Acquisition of woody material for charcoal production

Access to trees or woody material for charcoal production is critical. As indicated in section 2.2 above, land and tree tenure systems in Ghana do not usually permit the landless and migrant people such as the *sisaala* in the transition zone free

access to land and tree resources. Trees for charcoal if not from land owned by the producer has to be purchased or acquired at a fee or by some informal transaction between the producer and traditional authorities or land owners. Wood from logging residues and sawmilling wastes are usually purchased.

In the Upper West Region of Ghana, Lurimuah (2011) reports that a variety of trees used for charcoal production are harvested from the natural forest. The author also indicated that 88% of charcoal producers he surveyed use live standing trees felled in the natural forests (which confirms observations made by Riçerca Cooperazione, 2011). No fee is paid for harvesting such trees, unlike in the forest zone where these resources are purchased or paid for. This is because lands from which trees are harvested are usually family owned or communal lands, thus no permit is acquired for exploiting resources from such lands.

2.3.4 Financing charcoal production

Commercial charcoal production is sometimes pre-financed by middlemen. Most producers finance production from their own resources, mainly income from farming (Amanor *et al*., 2005).

2.3.5 Charcoal processing technologies

Throughout the developing world, charcoal is produced using earthen kilns or mounds for carbonization referred to as the traditional earth mound technology (Figure 7). The kilns are often built temporarily for each batch of production or cycle. This technology has been criticized as not being technically efficient as it is believed to waste raw material. It is also labour intensive and destroys vegetation at the production site (Lurimuah, 2011). The conversion efficiency ranges from 14% to 20% depending on the traditional method applied. The most efficient is the Sissala method that is about 20%. Despite this seemingly high efficiency a lot of energy is lost during the conversion process. Improving on this will bring in its wake enormous savings in wood (Riçerca Cooperazione, 2011)

The use of improved kilns built from earthen bricks and metal has also been introduced in Ghana. Whereas the earthen brick kilns are permanent ovens stationed at a designated production site, the metallic kiln once built is transferrable and simple to operate. The brick and metal kilns are reported to be very effective and efficient as it minimizes waste of wood and enhances

charcoal quality (Energy Commission, 2010). Hence, the government of Ghana has recommended its adoption.

Traditional earth mound-Daboase

Earth brick kiln-Akatsi-Forum

Metal kiln (INBAR-Daboasi)

Traditional earth mound: Sisaala-UWR

Earth brick kiln-Daboase (INBAR)

Metal kiln (Sudan)

Plate 1: *Charcoal production technologies in Ghana*

Despite its comparative advantage over the traditional earth mound technology, the initial investment cost for the acquisition of the brick and metal kiln remains a disincentive to its usage among traditional commercial producers (Energy Commission, 2010). According to Mason (2008), small scale charcoal producers using this earth mound technology on full time basis in some parts of the transition zone of Ghana, produce an average of 11-15 maxi bags per week. There is virtually no information on comparative technical and economic efficiencies between the brick and metal kilns and the earth mound technology.

2.3.6 Charcoal production process

Generally, charcoal production in most developing countries is done by stacking wood compactly in the dug-out pit or on the ground. The stack is covered with straw or other vegetation, and then buried under a layer of soil. It is ignited with burning embers introduced at one or more points at the bottom of the stack. The burning process is carefully monitored by opening and closing a succession of vent holes in the soil layer to draw the fire evenly around the

wood stack, heating the wood while burning as little of it as possible (FAO, 2000) until the entire wood is carbonized.

In Ghana the production process is as illustrated in Figure 8. The process commences with the identification of suitable trees. The trees are then cut or harvested, sorted by diameter and stacked next to the burning site or transported over a distance to the production site. The wood is then stacked into a dug-out earth pit or heaped on a relatively flat plain up to a reasonable height and covered with a layer of grass/ leaves and sand leaving two very small openings for fire to be lit and smoke exit respectively. Fire is then lit from the openings. After the entire stack of wood catches fire, the hole is sealed with small sticks and grasses.

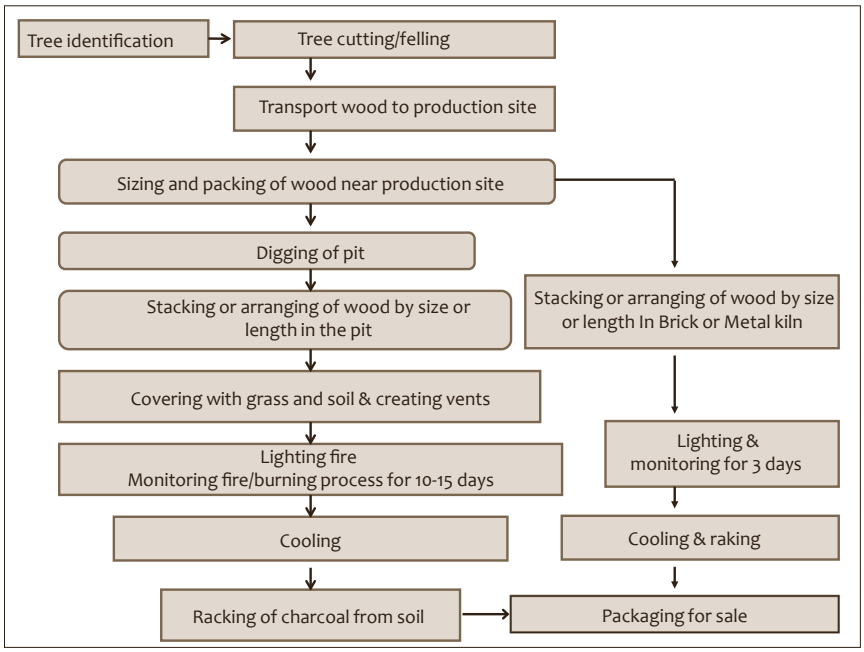

Figure 8: *Charcoal production process in Ghana (adapted from Lurimuah, 2011)*

The process is then closely monitored both day and night for about 10-15 days or a week or two, (depending on the size of the heap or the amount of woody material stacked and the moisture content of the wood) for the entire heap to be converted into the dark carbonized material called charcoal. As the wood burns gradually into the required charcoal, series of vents or openings are created in the earth mound to allow proper ventilation and continued burning during the carbonization period. Inadequate ventilation either smothers the fire before the carbonization process is completed or may cause over burning,

leaving only a pile of ashes. The process of carbonizing is completed when smoke from the pile stops and cools. The producer rakes and separates the dirt and debris from the newly formed charcoal. This process takes two to four days. The charcoal is filled into jute or synthetic bags (mini or maxi) for sale. It is estimated that the entire production process from tree identification to packaging of the charcoal for sale usually takes up one month for full time commercial production.

Charcoal production in the earth bricks or metal kiln also exists in the country although uncommon and not adequately reported in the literature. However, the production process and inputs required vary slightly from that of the traditional system (Figure, 8).

2.3.7 Charcoal marketing and consumption

2.3.7.1 Packaging, transportation & distribution

Charcoal is often packaged in sacks (maxi = 40-45kg in the transition and 50kg in the savannah) for distribution by trucks from production sites. A truck load of this comprises 150 bags on average (Mason, 2008) or 300 bags per truck load (Mombu, 2009). The quantity of bags per truck load depends of the size of the truck. The product is often transported over long distances by road from production sites in relatively old vehicles that are often overloaded (Plate 2).

Plate 2: *Trucks loaded with charcoal for distribution*

According to Riçerca Cooperazione (2011), over loading in this manner poses great danger to other road users as well as causing deterioration in road infrastructure. However, this is a common phenomenon for many other goods transported over land for inter-regional trade within the country and sub-regional across the borders to neighbouring countries. There are regulations on the use of over aged vehicles and overloading of vehicles for the transportation of goods but these are hardly adhered to or enforced.

The magnitude of the volume of production and trade in charcoal within and across regions in the country and across its borders is unclear. Riçerca Cooperazione (2011) distinguishes two streams of trading in charcoal within the borders of the country i.e. inter-regional and intra-regional trading. The inter-regional trade is dominated by medium to large-scale enterprises hauling charcoal across regions to main consuming centres mainly between the Savannah zone and the main urban cities in the country. It is estimated that 85 percent of the charcoal consumed in Kumasi, Accra and Tema metropolis is from the savannah and the transitional zones of Ashanti (Mampong and Ejura districts); Brong Ahafo (Kintampo, Attebubu, and Nkornza districts) and the Afram Plains, whilst the remaining 15 percent are from the coastal savannah

ecosystem. On the other hand, the intra-regional trade is dominated by small to medium-scale enterprises, moving charcoal from within the regions mostly from the supplying villages to the consuming centres. In Accra, Kumasi, Tamale, Bolgatanga and Wa, charcoal may be produced from within a radius of 10 km and over very long distances to supply urban demand. Most households in the urban centres generally depend on charcoal markets that are dotted all over, retailing small quantities by various units of un-standardized measure of sale. However, charcoal markets are uncommon in the rural areas because most households gather firewood from farms and in the wild to cater for their domestic energy needs (Riçerca Cooperazione, 2011).

A study by BOG (2004) showed that Ghana is likely to consume more than 25 million tons of wood fuel by the year 2020. According to the Food and Agriculture Organization (FAO) about sixty nine percent of all urban households in Ghana use charcoal for cooking and heating and the annual per capita consumption is estimated at 180 kg. The total annual consumption for the country is estimated at approximately 700,000 tons, of which 30% (210,000) is consumed in the capital, Accra. Also, 30 percent of Ghana's rural and urban households depend solely on charcoal for their main cooking fuel and further 9.2 percent use it as back-up fuel source while 55 percent use fuel wood for the same purpose, (Toyola Energy, 2010).

2.3.8 Constraints in the charcoal supply chain

The traditional charcoal supply chain is constrained by a number of challenges. Two key constraints charcoal makers encounter are scarcity of suitable hard or heavy density wood species for quality charcoal and increase in dust when available less suitable species are converted into charcoal. Charcoal makers indicated that charcoal dust reduces the quality and quantity of charcoal produced and suggested support for establishment of woodlots with some desirable species to overcome this problem (Brefo *et al.,* 2012).

Also, the acquisition of official permit for harvesting wood fuel from production forests is cumbersome and may be associated with high transaction costs. While wood fuel collectors generally are reluctant to travel long distances to District Forest Offices to acquire permit, lack of capacity on the part of the FSD to assess/inspect exploration sites before issuing permits delays the process. Further, many charcoal producers are not in co-operatives. Hence, are not properly connected to aid in coordination of resource acquisition and supply of charcoal products (Brefo *et al.,* 2012).

Traders on markets also report of poor quality of charcoal supplied often resulting in production of heaps of charcoal dust on such markets (Plate, 2). Also the price per unit of charcoal is increasing by the day. The traders have inadequate financial capital for business operations and often encounter untimely supply from the production areas. Similarly, consumers expressed concerns with poor quality and high prices of charcoal (Obiri and Nutakor, 2011).

Plate 3: *Heap of charcoal dust on an urban market*

Source: Obiri and Nutakor, 2011

2.4 The effect of wood fuel and charcoal production on the environment

Naturally, any disturbance from natural adversities and/or anthropogenic factors including farming, logging, wood fuel extraction, hunting, bush burning, over grazing, wild fire, etc. alter biodiversity in any ecosystem. Kindt *et al*, (2008) reports significant differences in species compositions in farmed parkland and a nearby ecologically intact forest reserves in Nigeria, Burkina Faso, Mali, Niger and Senegal.

Similarly, tree-cutting for fuelwood particularly in savannah ecosystems of Ghana can potentially have adverse ecological impact on such systems. Change in species compositions are likely as cutting influences the survival

and reproduction of preferred fuel species relative to less preferred species. Further, tree species which do not coppice may disappear altogether. Some tree species may have recalcitrant seeds with low probabilities of regenerating naturally. Also charcoal and fuelwood producers rely mainly on the natural vegetation for their wood supplies without any efforts to plant or nature desirable species. Thus certain wood fuel species such as mahogany has become scarce in the savannah belt of Ghana for the past decade (Pabi and Morgan, 2002). In the Wa East and the Sissala Districts of the Upper West Region Lurimuah (2011) observed that trees are usually cut at 40 cm above the ground level with axes, cutlasses and chainsaws. Such harvesting methods may impede tree rejuvenation or coppicing, since the entire stems of the trees are often cut-off haphazardly.

However, studies done by Amanor *et al*., 2005 in the Kintampo North District indicate that tree stands burnt and used as yam stakes on farms and later harvested for charcoal production regenerated from coppice growth. Most of the dominant charcoal species coppiced profusely. These included *Ficus exasperata* (pru), *Nauclea latifolia* (kankano), *Pseudocedrela kotschyi*, *Burkea africana*, and *Pericopsis laxiflora.* The authors observed that regeneration was faster on newly cleared farms abandoned after one-two years of cultivation than those that have been cultivated continuously. Also, within a period of 6-10 years most of the species are able to regenerate to a size in which they can be re- exploited. The authors argued that charcoal production in the Kimtampo North District does not necessarily destroy the environment as wood used is burnt stake from yam farms and most of the species coppice or regenerate easily.

Generally, some measures have been pursued by the government of Ghana and other agencies to reduce pressure on the natural forest stand and ensure sustainable use of available wood fuel resources in the country. These include:

- Promotion of planting of trees
- Campaign for the use of Liquefied Petroleum Gas (LPG)
- Taxation, such as the introduction of stumpage royalties on fuel wood trade.
- Ban on the fell of some tree species even when they are on farmland.
- Introduction of wood fuel conserving devices (Gyapa coal pot, etc.).
- Introduction of modern charcoal production techniques (metal & earth kilns)

However, these measures have not contributed adequately to relieve the high demand for wood fuel in the country. Arnold and Persson (2003) emphasized that both rural and urban dwellers in some developing countries have developed a strong preference for the use of charcoal. As a result any attempts to ban the production or the use of charcoal will be unsuccessful mainly due to the interplay of socio-economic interests.

2.5 **Gap in knowledge**

Despite the attempt to put in place a draft bio-energy policy to provide the framework for efficient utilization and sustainable supply of wood fuel resources, Riçerca Cooperazione (2011), reports that Ghana hardly has a formal wood fuel policy neither does the country have accurate and consistent data on wood fuels to guide policy formulation and planning. Further, there are no comprehensive and consistent data on the stocks of wood fuels available in the country by ecological zone, neither are there any data on the levels of wood fuel consumption by the various sectors of the national economy. At the macro level, aggregate data are inferred from very weak database, which does not provide any meaningful basis for planning. Also, there are no explicit statutory regulatory mechanisms to guide the wood fuel business at the District levels. Although some District Assemblies have bye-laws to regulate wood fuel marketing in the form of levies, the entire operations from production through transportation to marketing remains unregulated. Even where levies exist, the compliance and enforcement are very weak with less than 18 percent compliance rate (Riçerca Cooperazione, 2011 citing Savannah Resource Management Progamme Report, 2001).

Other pertinent gaps in the information on wood fuel and charcoal enterprises aside unreliable data include lack of information on the following:

1. Comprehensive analysis of the value chain for charcoal in the country.
2. Silvicultural management and regeneration of the natural vegetation for wood fuel and charcoal production. Thus producers often have very little knowledge or none on silvicultural management of wood resources harvested for charcoal production.
3. The potential or establishment of wood fuel plantations for charcoal production, although some attempts for cassia plantations have been introduced in coastal areas in the Central and Volta regions by MoFA, FSD and Forum project in the country

4. Carbon sequestration potential of wood fuel plantations
5. Compilation on the silvilicultural and energy characteristics of available species for woodfuel and charcoal to guide the use of alternative species in charcoal production
6. Nationwide supply and consumption trends for wood fuel and charcoal to estimate the magnitude of supply and demand within the country and across its borders overland
7. General economics of charcoal production with available technologies from natural wood fuel resources and plantation production
8. Comparative technical and economic production efficiencies of the improved charcoal burning kilns over the traditional earth mound technology

2.6 **Conclusions**

Over the years, charcoal production has been an important livelihood activity for most rural communities particularly within the transition zone and savannah woodlands, as urban demand increases. The expansion of charcoal production has been of great concern since the early 2000 as this activity is perceived to contribute significantly to deforestation. According to Brown and Amanor (2006) this necessitated the introduction of a ban or control on charcoal production in intensive charcoal production areas in the Kintampo area in the transition zone of Ghana. The controls focused on the introduction of improved technologies for more efficient burning of charcoal, and encouraging production from woodlot but this did not materialize.

This literature review has revealed that literature is replete with information on the charcoal supply chain in Ghana. The industry is a key source of livelihoods for many actors in the supply chain and production is largely based on woody resources in natural stands. Conversion of wood is largely by the traditional earth mound technology. However, quantitative empirical information on production volumes, magnitude of resource flows among others, upon which policies for sustainable development of the industry could be based, is limited. Also, hardly any comprehensive research has been undertaken to assess the silvicultural and energy characteristics of species used in charcoal production, rate of extraction, regeneration potential and the like for the development of appropriate silvicultural regimes for sustainable management of wood fuel resources in the country. The suitable raw material base for charcoal burning

is declining. Hence, pragmatic steps need to be taken to safeguard the raw material base while considering the promotion of the charcoal enterprise for livelihood enhancement and poverty alleviation.

There is also the need to extend knowledge on the management of wood fuel resources to local communities who depend perpetually on these resources for livelihood. Producers need to know resource stocks available and how they can manage stocks as well as grow the resource to sustain production.

A multi-stakeholder platform is required to organize wood fuel and charcoal actors, including producers, traders and transporters as well as relevant government and non-governmental agencies in the sector for policy planning. The platform may be relevant in discussing policy issues related to the production and regulation of raw material and products at the district and national levels. The creation of local charcoal management board at the district level could aid in the regulating of charcoal production and also increase economic returns for charcoal producers. Key members of the charcoal management board and linkages could be as illustrated in Figure 9.

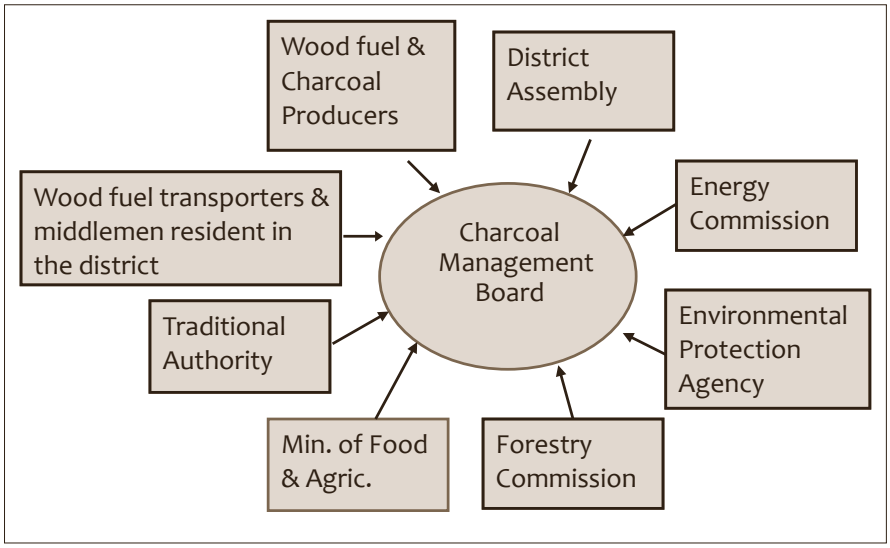

Figure 9: *Members of district level charcoal management board*

3 AN ANALYSIS OF THE GHANAIAN CHARCOAL VALUE CHAIN

Summary

Charcoal and firewood constitute the most important energy forms in Ghana. Charcoal production, transporting and marketing employs and serves as a source of livelihood to many households. This study analyzed the charcoal value chain in Ghana based on information gathered from the Afram plain and Ejura Sekyeredumase Districts in the Eastern and Ashanti Regions respectively. The study specifically entailed an analysis of key marketing channels and actors involved in the charcoal value chain, the coordination between the actors and how the costs and benefits of value added is distributed between the different actors. 318 value chain actors comprising 204 producers, 32 transporters and 82 marketers were randomly selected and interviewed using semi-structured questionnaires as well as focus group discussions.

Charcoal production was found to be an important economic activity in the study area. Along the value chain males dominated the production (88.2%) and transporting (100%) aspect of the chain while the females controlled the marketing (93%). Charcoal production was found to be more tedious than the marketing aspect. Trees with dense or heavy wood are preferred for charcoal but due to scarcity producers move from one community to another in search for such trees. The high demand for charcoal is a key driver to charcoal production as there is ready market for the product. Demand for charcoal is inelastic as consumers are prepared to pay double the price. The availability and price difference of charcoal compared to LPG, electricity and other petroleum products, contribute to the inelastic nature of charcoal. Determining the charcoal performance, it was found that the market is opened although it is not formal. Trade of charcoal between the producers and marketers was found to be built on trust. Producers enjoy 40% of the price spread in the value chain while, the other participants in the chain enjoy the remaining 60%. The producers receive only 13.3% of the producers share with the remaining 26.6% being production cost. Comparing percentage share from the price spread, the marketers and transporters are better off with profit than the producers.

Unavailability of trees, poor road network and harassment from police are the major challenges encountered along the chain. Establishing woodlots coupled

with effective and comprehensive straightforward approach that recognizes the interdependencies between the different segments of the chain will enhance the charcoal value chain in Ghana.

3.1 Introduction

Charcoal is produced from fuel wood. Hall *et al*., (1996) estimated that about 100 metric tons of charcoal is produced annually worldwide, although this figure may be regarded as a conservative estimate. Charcoal is mostly produced from forestry residues resulting from the expansion of agriculture and pasture land, waste from wood processing sawmills and forestry's thinning and more professionally from biomass plantations. Charcoal production is an integral part of the informal economy of many developing countries and utilized by small scale operators involving a large number of small farmers and rural poor people. Duku *et al.,* (2011) indicated that the primary energy supply in Ghana is based on biomass, mainly firewood and charcoal sixty four percent, petroleum twenty seven percent and electricity nine percent. The average annual energy consumption and primary sources in Ghana in the year 2000 is presented in Table 5.

Table 5: *Annual energy consumption in Ghana*

Electricity	Oil and derivatives	Charcoal	Wood fuel
7,838,000 Mwh	1,095,000 Tonnes	1,000,000 Tonnes	8,200,000 Tonnes
		10,700,000m3	10,900,000m3
8.0%	13.2%	44.6%	34.2%
674,100 TOE	1,095,000 TOE	3,745,000 TOE	2,870,000 TOE

Source: Ghana Energy Commission 2000
(TOE = Tons of Oil equivalent)

According to Duku *et al*., (2011), energy demand in Ghana has increased significantly in recent times as a result of population increase and urbanization, adding that, the increased demand is, however, more pronounced in the consumption of wood fuel, particularly wood charcoal. Charcoal happens to be the most used energy in Ghana. There is a kind of ladder of energy sources in the urban areas that people generally climb as their income increases: from

firewood at the bottom, through charcoal, kerosene and LPG, to electricity at the top (Kammen and Lew, 2005).

3.1.1 Concept of value chain

Value Chain is defined as full range of activities which are required to bring a product or service passing through the intermediate phases of production to delivery to consumers and final disposal after use (Kaplinsky (2000). Bellù (2013) also explained value chain a set of interdependent economic activities and to a group of vertically linked economic agents, depending on the scope of the study. The focus of analysis can be on the activities or on the agents. Nevertheless, a value chain starts with the production of a primary commodity and ends with the consumption of the final product and it includes all the economic activities undertaken between these phases such as: processing, delivery, wholesaling, and retailing (Figure 10). Although there are different approaches for value chain research, Schipmann, (2006) stated that institutional and other aspects like legal framework need to be considered in the value chain.

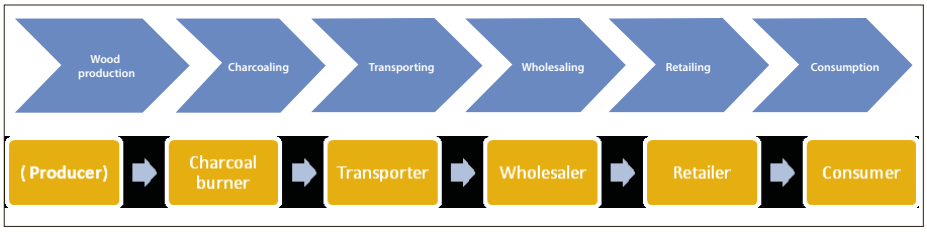

Figure 10: *A visual representation of different aspects and actors of a value chain*

Source: Murererehe et al., 2011

There may be variable number of actors in any one value chain depending on the product type. In the value chain each actor is customer of an upstream actor as well as supplier of a downstream one belonging to the chain. The actor can be a physical person such as a producer, a farmer, a trader, a consumer, etc., or a legal entity, for example, an authority or a development organization. According to Gereffi, (2004) the value chain consists of five dimensions comprising technical structure, the actors in a chain, the territorial, the input output and the governance structure. Questions of how production is done, who participates at which stage, where do the different stages take place, how they are linked, who has which benefits among other are answers provided when the various structure of the chain is analyzed. These answers are required to find the relevant points of intervention for a successful integration of poor population sections.

In Ghana, charcoal value chain plays a very significant role in the economy, employing many households directly and indirectly. The charcoal value chain also plays a significant role in the environmental sector in Ghana with wood for producing charcoal consuming great proportions of the country's energy balance. The analyses of the sector allow for exploration of the opportunities in the sector and discover what added value could be provided with a value chain intervention. In order to improve the charcoal value chain, it is important that the key stakeholders, their roles, activities, relationships to other stakeholders and constraints are clearly defined. Furthermore, it is important to be aware of relevant policies and regulations and possible areas of intervention. For policies to be effective, a comprehensive approach is needed that recognizes the interdependencies between the different actors in the charcoal value chain as well as taking into account various multitude dimension such as economics, social, etc.

3.1.2 Structure of the report

This report broadly entails an analysis of the key marketing channels and actors involved in the charcoal value chain, the coordination between the actors in the chain and the distribution of costs and revenues from value addition between the different actors as the product moves from the producer to the consumer. The report covers a brief introduction to the charcoal sector in Ghana and at global level, review of relevant literature, study objectives, description of the main features of the study area, methods of data collection and analysis, findings, discussion and conclusion.

3.2 Methodology

The study was conducted in the Afram Plains and Ejura Sekyeredumase Districts in the Eastern and the Ashanti Regions respectively. The districts are two of the major charcoal producing districts in the southern sector of the country. The bio-physical characteristics of the districts are presented in Table 6.

Table 6: *Characteristics of Study Area*

Characteristics	Afram Plains	Ejura/ Sekyeredumase
Location	Located in the Northern - most part of the Eastern Region. Located between Latitudes 6o 40I N and 70 10'1 N; longitudes 0O 40I E and 0o 10I E	Northern part of the Ashanti Region longitudes 1˚5W and 1˚39' W and latitudes 7˚9' N and 7˚36'N
Land size	3,559sq. km	1,782.2sq.km
Topology	Generally of low lying lands. 60 metres to 120 metres above sea level	Fairly rolling with valleys and peaks. Averagely, the valleys have a depth of about 135m whilst the peaks rise to about 315m above sea level
Vegetation	Falls within the forest-savannah transition zone and with certain parts having savannah wood land	Transitional zone of the semi-deciduous forest and Guinea Savannah zones. The northern part is covered with sparse derived deciduous forest vegetation
Climate	Bi-modal rainfall pattern. Annual rainfall ranges between 1500 to 2000mm and 900 to 1300mm for the peak and lean period respectively	Bi-modal pattern in the south and the uni-modal in the north. Annual rainfall varies between 1,200mm and 1,500mm.
Soil type	Soil is Haplic luvisols constituting over 40% of the land area and belong to the Ejura Series.	Soils in the district are of the Savannah Ochrosol type which is mainly made up of sandy loam or clay.

Source: Ghana Districts, 2013

3.2.1 Data collection

Primary and secondary data have been made used in the study. Both qualitative and quantitative primary data was collected from the various agent or actors of the value chain based on structure presented in Figure 11. The figure illustrates the basic agents or actors and corresponding cost items associated with activities undertaken in the chain as the product moves in the raw material form through carbonization into charcoal for transportation/ distribution to markets and to the final consumer. The figure is adapted from a description of the charcoal value chains in Uganda and Rwanda (Sepp, undated and Murererehe *et al.,* 2011) and based on an understanding of the Ghanaian charcoal supply chain described in Chapter two of this report.

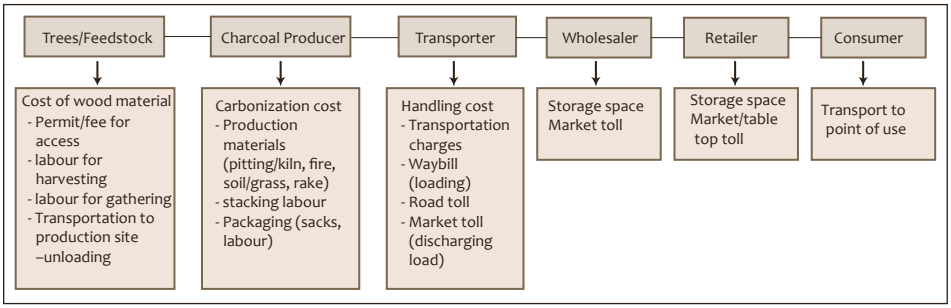

Figure 11: *Basic components in a charcoal value chain (Adapted from Sepp, S. Undated and Murererehe et al., 2011)*

The different charcoal value chain actors were interviewed with questionnaires. Observations of the activities of the actors in the chain were also made. In addition, expert interviews were conducted. The sample of respondents interviewed is presented in Table 7.

Table 7: *Sample collected for the study*

Actors	Ejura Sekyeredumase District	Afram Plains District	Total
Producers	96	108	204
Transporters	20	12	32
Marketers (wholesalers and retailers)	65	17	82

The data collection was undertaken from February to March, 2013. A semi structured questionnaire was used to collect relevant primary data from charcoal producers, transporters, wholesalers and retailers based on their recall of activities and associated costs and revenues. The questions were administered in local language *Akan.* Focus group discussions were also held with respondents made up of charcoal producers, transporters, marketer and consumers using a checklist. During the interview care was taken to explain the objectives of the study to the respondents and to avoid unwanted information.

3.2.2 Data analysis

The analysis of the data collected involved simple descriptive statistical tools like averages, percentages. Price spread was determined by computing the differences between the prices received by the producers and prices paid by the consumer.

Price spread = Pp-Pf

Where,

Pp = prices paid by the consumer

Pf = prices received by the producer

3.3 Results and discussion

The charcoal value chain is made up of many different stakeholders who participate in the following activities: charcoal production, transporting, Marketing (wholesaling and retailing), and consumption. The purpose of mapping is to outline the different stakeholders from production to consumption.

3.3.1 Characteristics of actors in the Ghanaian charcoal value chain

3.3.1.1 Charcoal producers

Charcoal production was identified as one of the most remunerative among the forest related activities and also constituting a major source of income and employment among individuals in the study areas. In the study, two distinct

groups of charcoal producers are noticeable. First, there are farmers who produce charcoal as part of secondary activities. The second group comprises of charcoal making specialists for whom charcoal making forms their primary activity. From our field survey conducted among the rural communities, it was noted that because charcoal production is considered illegal, many people were reluctant to discuss their charcoal making activities. From the study 88.2 % of the producers were males while the remaining 11.8 % were females. Figure 12, shows the gender composition in charcoal production. Traditional charcoal making is a very tedious operation and requires an intimate practical knowledge of the principles of combustion. The producers indicated that activities involved in charcoal production such as cutting down tree, packing trees, casting sand and grass over the pilled wood and setting fire is labor intensive and muscular in nature therefore difficult for the females to undertake such activities. It is of no doubt that the females are few in charcoal production.

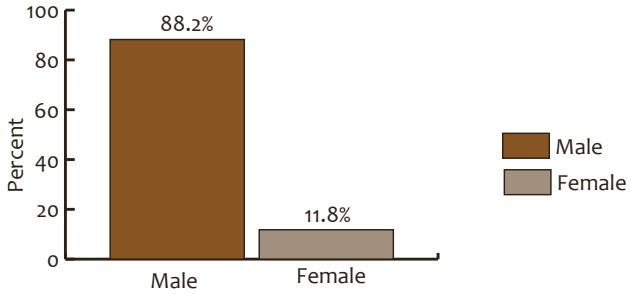

Figure 12: *Gender of charcoal producers*

Source: Field Survey, 2013

The average age of charcoal producers was 35 years, ranging from 19-70 years. Fifty-three percent of the producers had no formal education, 16.2% have had education to the primary level, while 23.5% had up to Junior Secondary School (JSS) and 6.4% up to the Senior High School level (SSS) (Figure 13). Although half of the producers were not formally literate, they indicated that this did not have any effect on their skills and output, since the technology and skills required are not difficult to learn. Rather, perfection comes with practice.

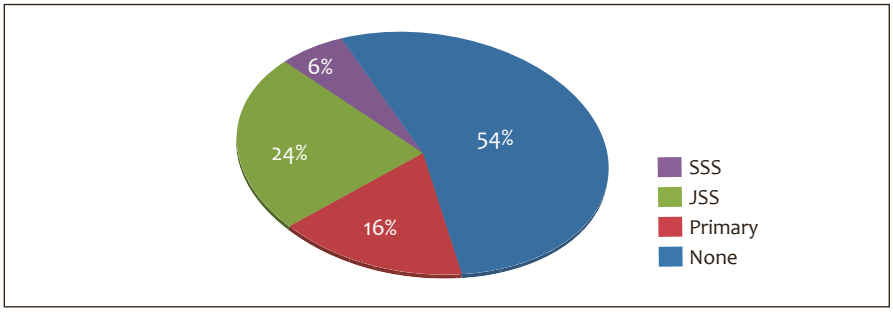

Figure 13: *Educational level of producers*

Source: Field Survey, 2013

Almost all charcoal in the country is produced in the rural areas. The majority of the production occurs for commercial reasons as in the rural areas firewood is mostly used for cooking. Charcoal production is more or less a zero-cost activity with most producers collecting wood for free, use their own labour and make a negligible initial investment to buy the basic tools required to set up the activity (i.e. axe, machete, hoe, shovel and fork). With the stocks of raw material at a highest rate of depletion, charcoal makers currently need to travel over long distances to procure wood for burning.

Charcoal producers access their wood for charcoal from many sources, but mainly from three sources, own farms, forest and both own farm and forest. It was observed that 64% of the producers access their wood from their own farms. 14% access their wood from both the forest while the remaining 22% get their wood from the forest.

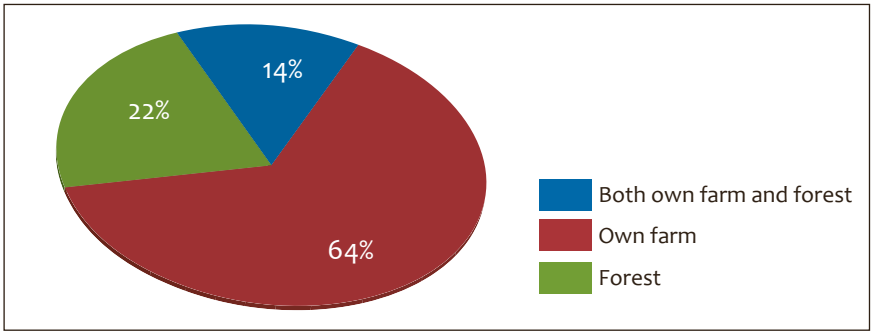

Figure 14: *Source of wood for charcoal production*

Source: Field Survey, 2013

Preference and suitability of trees used for charcoal burning varies with the type, size, availability and accessibility of the tree species. The respondents

indicated that large tree species with high caloric values are the most preferred, due to the large quantity of dense and hard charcoal they produce from them if such tree characteristics are not easily available or accessible, other tree species with low calorific values are used as well.

The production of charcoal require experience and constant practice, some of the charcoal producer have been in the production business for over four, while the least person have spent a year in charcoal production. The average experience in charcoal production is 10 years. Most of the charcoal producers leant it from friends although few have charcoal production as their family business that is seen to be running through their older generations till date. According to the survey, charcoal making specialists for whom charcoal making forms their primary do not spend more days in making charcoal on average and also much more efficient due to their experience.

According to producers, the most important factor motivating their involvement in charcoal production is the fact that charcoal is a commercial product, with a large market ready to absorb the entire production. Charcoal producers with a cycle of production in a month can produce maximum output of 700 mini bags (50kg) which with an average output of 164 mini bags (50kg). Charcoal production peaks mostly in the raining season in the month of April-August as indicated by the producer. The producer further indicated that during that period grass for covering the piled wood for charcoal is readily available more so it very easy to dig and cast soils onto the pilled wood. Despite high production during such period getting charcoal from production site is a challenge due to the poor road network.

Only 20% of the producers interviewed do transport their charcoal up to wholesalers/ retailers in the city of Accra and Kumasi. They usually do this only when their close relations (parents, wife, husbands etc.) act as wholesalers/ retailers in the major cities and also there is the opportunity to retain a higher margin of profit there. The income generated from charcoal businesses has significant advantages to both women and men. The cash income is typically used to satisfy family needs such as paying school fees, medical care and investment for agriculture.

Findings from the study showed that some charcoal producers act as nomads, moving from village to village, community to community, region to region in search for wood to produce charcoal. elow Charcoal producer's movement in search for trees from one community to another to produce charcoal.

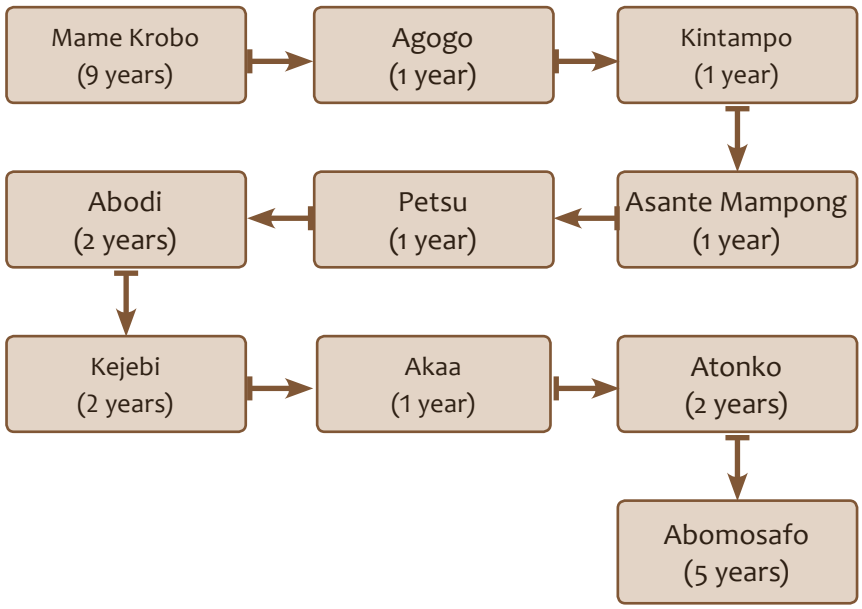

Figure 15: *Communities visited and number of years spent by a charcoal producer*

Source: Author's construct, 2013

Challenges encountered by producers

The key the constraints crippling the activities of charcoal producer is the unavailability of wood for burning. Producers indicated that there has been a drastic decline in the quantity of charcoal produced now compared to what was produced half a decade ago. Producers predict a bleak future for the industry as 75% of them anticipate a decline in production volume in the near future. This they attributed to deforestation and impact of other unsustainable forestry activities.

Although co-operatives have the potential to improve revenue to the producers through collaboration and information sharing few of the charcoal producers are in co-operatives. This co-operatives formed are not properly connected to relevant stakeholders or recognized sufficiently by public institutions. Also, charcoal producers lack business skills. This hinders their ability to better manage their businesses and market their product appropriately.

3.3.1.2 Charcoal transporters

Almost all charcoal produced in rural areas is transported to the main cities by trucks. A small percentage of the charcoal transporters use bicycles and tractors to transport from the production site to the road side. More charcoal is transported during the dry seasons for reasons related to the larger quantity produced and the better condition of the roads. All the charcoal transporters interviewed were males with average age of 36 years although the oldest transporter of charcoal was 56 years with the youngest been 23 years. From the study 59% of the transporters have formal education to the Junior Secondary School level. Out of the remaining 41%, only 3% have formal education up to the Secondary School level. 19% each of the respondents have had either primary or no formal education (Figure, 16).

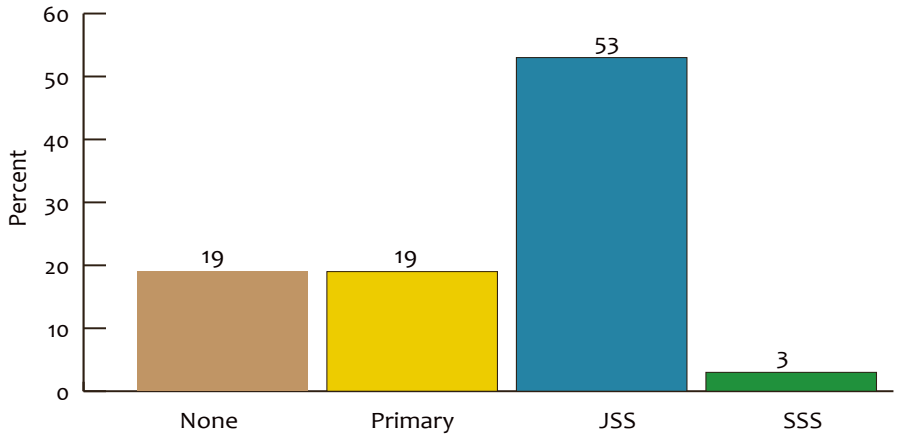

Figure 16: *Educational level of charcoal transporters*

Source: Field survey, 2013

The transportation of charcoal have been a major commodity for mast 95% of the transpoters interviewed. The average transporter have been 7 years in charcoal transporting business although some have been in the business for the past 23 years. Due to the poor road networks that exist in charcoal producing sites two levels of transportation normally occur. The first level of the transportation is that, the transporters transfer the charcoal from the charcoal producing site to the road side; this is mostly done by tractors and bicycles and for the second level charcoal is transported from the road side to the retailers in urban areas.In some instances there is only one transportation levels where the trucks picks charcoal directly from the production site to the major cities. From the study it was found out that 65% of the respondents

convey the charcoal from the burning site whiles the remaining 35% onload charcoal from the road side. Charcoal is brought to markets or small retailers where it is sold to consumers or directly to consumers. The transporters only move the charcoal to its final destination and they are paid by the owners of the charcoal for utilize the trucks. In order to transport more than 10 bags of charcoal, transporters are required to have a transport permit for charcoal and specifically for a certain vehicles. The permit is granted for every load transported. In order to receive a transport permit the driver of the vehicle pays fee that is relative to the capacity of the vehicle in relation to the total number of charcoal it transport. The fee ranges from GHC20- GHC40. Less than 200 mini bag capacity vehicles pay GHC 20 and above 200 mini bag vehicles capacity pays GHC 40. The permit is granted by the District Assemblies and the fee varies by Districts. Almost all the transporters indicated that, they operate weekly cycle of transportation due to the distance from the charcoal production communities to the final consumer in the cities. On the average every transporter is able to move 320 bags of charcoal from production site to the final destination.

Major challenge that is been encountered by the transporters are the poor road network which delays the number of days in reaching the final destination. More so harassment from the police is also a big challenge as claimed by the respondents.

3.3.1.3 Charcoal marketers

The marketing of charcoal in Ghana is primarily informal.. Throughout cities and communities visited, charcoal marketing is evident. Roads are lined with charcoal bags for sale in both city centers and the outskirts. According to the marketers, all stocks produced are promptly consumed. The marketing of charcoal is been done by two main parties; wholesalers and retailers. Some of the marketers interviewed were as young as 15 years with some too as old as 60. The average age for the marketers from the study was 38 years. On the average marketers have 9 years of experience in charcoal marketing. Out of the total number of marketers interviewed 93% of them are females with only 7% percent being males (Figure 17). This is an indication that the marketing of charcoal is mostly done by females. It is therefore presumed that marketing of charcoal is not as tedious as that of production.

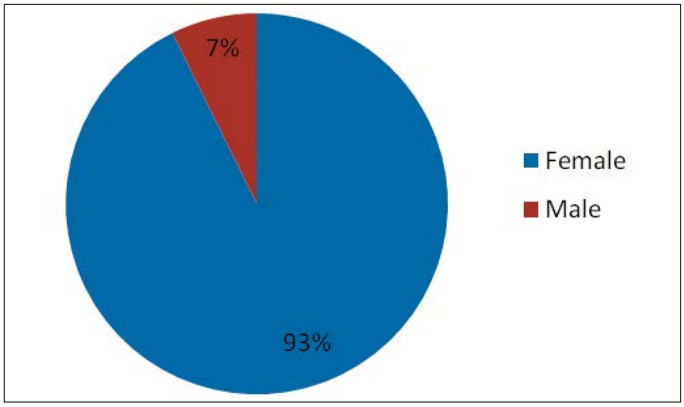

Figure 17: *Gender of charcoal marketers*

Source: Field survey, 2013

Figure 18 shows the level of formal education among charcoal marketers. Majority of the marketers consisting of 54% have had formal basic education, while 46% have none. As indicated by the producers, marketers are of the opinion that skills for marketing charcoal are acquired on the job. However, one would expect that, the generally low level of literacy among these actors in the value chain may affect their business management capabilities.

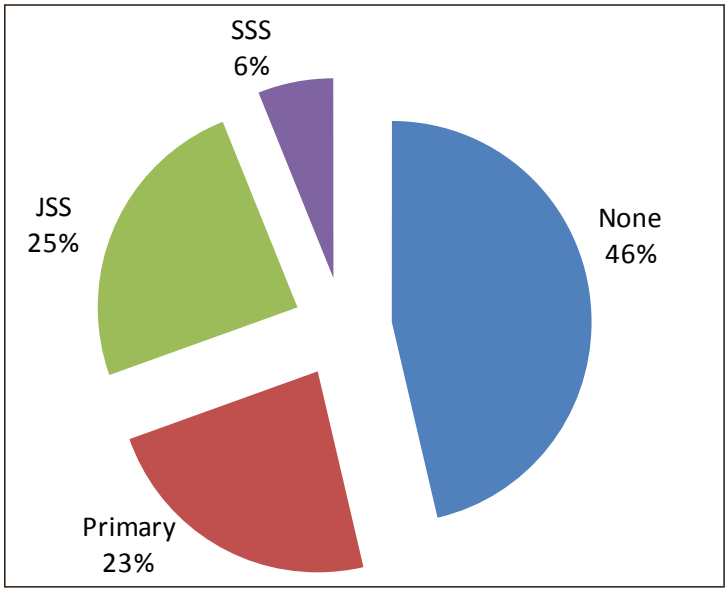

Figure 18: *Educational level of charcoal marketers*

Source: Field survey, 2013

From the study three forms of payment systems exist between the marketers and producers of charcoal. Either marketers pay cash up front for goods purchased or delivered or make advance payment before the charcoal is supplied or pay after selling the charcoal. Seventy percent of those who market charcoal make cash payment when charcoal is supplied by producers (Figure 19).

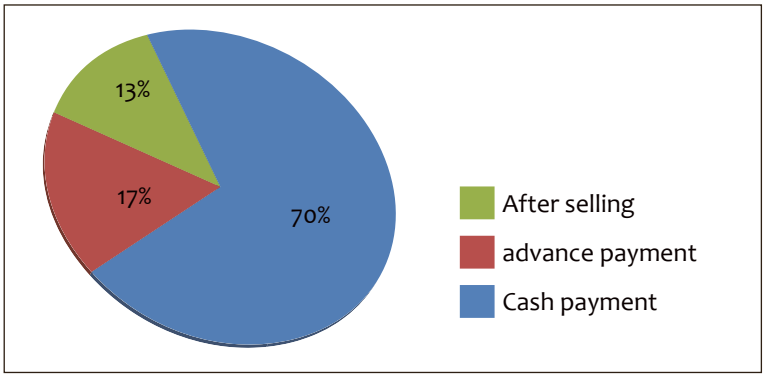

Figure 19: *Terms of payment by charcoal marketers*

Source: Field Survey, 2013

Results from the survey showed that 85% of the respondents are wholesalers while the remaining 15% comprised retailers.

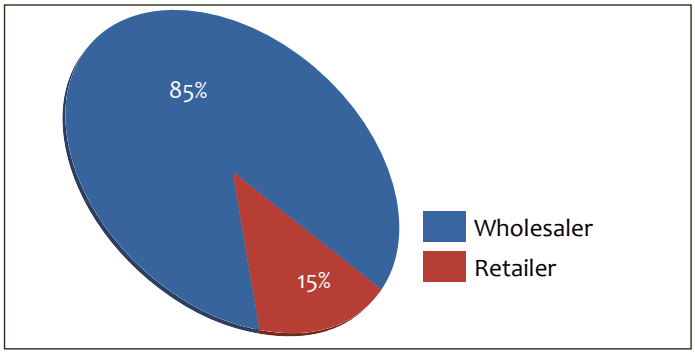

Figure 20: *Types of charcoal marketers*

Source: Field survey, 2013

3.3.1.4 Charcoal wholesalers

The charcoal wholesalers buy charcoal directly from the producers, other times they buy from the agents/middlemen. Charcoal is sold to the retailers in

the urban areas or individual consumers. Wholesalers buy in large quantities between 100-300 mini bags per week. One major constraint encountered by the wholesalers is the unavailability of reliable transport systems and the poor road network. This constraint is a contributing factor to high cost in transportation.

3.3.1.5 Charcoal retailers

Charcoal retailers sell charcoal directly to consumers. Retailers are scattered around the urban centers and markets. Charcoal is sold in bags of various sizes. Many retailers sell out in kiosk and open air sheds. Charcoal is sold in poly bag and small metal containers. Retailers always have a large enough stock of charcoal that can sell for 14 days in Accra and Kumasi (approximately 60 bags). The respondents indicated that good quality charcoal is easily recognizable because of its high density and lustrous black color. Despite the transport costs, being a charcoal retailer remains a lucrative activity. In fact, thanks to their strategic position in the chain, the retailers retain the highest margin of profit and are far better off than the producers. The major constraints to retailers are the poor storage capacity and lack of business management skills as indicated by the respondents. Improved business skills could lead to better organization, planning and product marketing.

3.3.1.6 Consumers

Charcoal is consumed almost solely in urban and peri-urban areas. In rural areas where charcoal is produced, people normally use firewood. Consumers buy charcoal from various sources, such as stores, markets, kiosks and trucks, located in the city centre and outskirts. Households represent the most significant source of charcoal demand in the city by far. The second largest consumer of charcoal is the commercial sector, which consists of petty food vendors and restaurants whereas the service sector, consists of secondary schools, colleges, hospital/health centers and prisons, represent a marginal share of the total demand for charcoal. Increasing scarcity of charcoal during the raining season is a contributing factor to price variation in the cause of the year. Demand for charcoal is inelastic as most respondents to our survey claimed they would continue to buy charcoal even if the price doubled. High price of alternative fuel like kerosene, Liquefied Petroleum Gas (LPG) and electricity is directly related to the inelastic nature of charcoal demand in Ghana.

3.3.2 Performance in the charcoal value chain

The performance in the chain was assessed through variables like market structure, transparency, trust in the trade and flow of information. This was found based on the interactions and interviews made with all the charcoal producers and marketers.

Table 8: *Performance of charcoal actors in the value chain*

Chain structure	Performance level
Market structure	Open market
Transparency	Low to medium
Trust in trade	Medium
Information flow	Low to medium

Source: Field survey, 2013

In Ghana, the market for charcoal is informal and open where the producers are free to sell their produce to any buyer. Findings from the survey showed that producers had less price negotiation for their produce while the information flow was found to be low to medium. Again marketing of charcoal was found to be highly influenced by trust since most of the producers (75%) interviewed said they sell their produce to the marketers they trust. Moreover trade of charcoal between the producers and marketers is mostly due to the trust gained over the years. Transparency in the trade of charcoal was found to be low on the path of both the charcoal producers and marketers.

3.3.3 Price spread along the charcoal value chain in chain

The prices of charcoal have been fluctuating periodically. Interaction with marketers indicated that the price in a single year (2012/2013) varied from GH¢4.5 to GH¢6/50 kg bag. High transportation cost and scarcity of trees were the main factors considered by the respondents to be influencing the prices of charcoal. Lower prices affect the producers to a large extent.

The price and profit margins as the bag of charcoal is moved in the distribution chain is observed in Table 9 and Figure 21. Costs incurred by producers include production, bagging charges, transportation to road side or market depot commission charges, labour charges for loading and unloading. Costs incurred

by other intermediaries include transportation, labour charges, Packing material cost, tax, license fee, commission charges.

Results showed that there is a huge difference in the prices obtained from the producer at the production site to the retail prices. The producer share was 40 percent of consumer price. The producers receive only 13.3% of the producers share with the remaining 26.6% being the production cost.

Table 9: *Price spread in the charcoal value chain in Ghana*

Particulars	GH¢/50kg bag	Percentage
Producers cost	4	26.7
Price received by producers	6	40
Agent/middlemen purchase price	6	40
Cost of Agent	0.5	3.3
Net margin by the agent/middlemen	***1***	***6.7***
Selling price of agent/middlemen	7.5	50
Price received by wholesalers	7.5	50
Cost of Wholesaler	3.5	23.3
Net margin by the wholesalers	***2.5***	***16.7***
Selling price of wholesalers	13.5	90
Price received by retailers	13.5	90
Cost of retailers	0.20	1.3
Net margin by the retailers	***1.30***	***8.7***
Selling price of retailers	15	100
Price spread	9	60

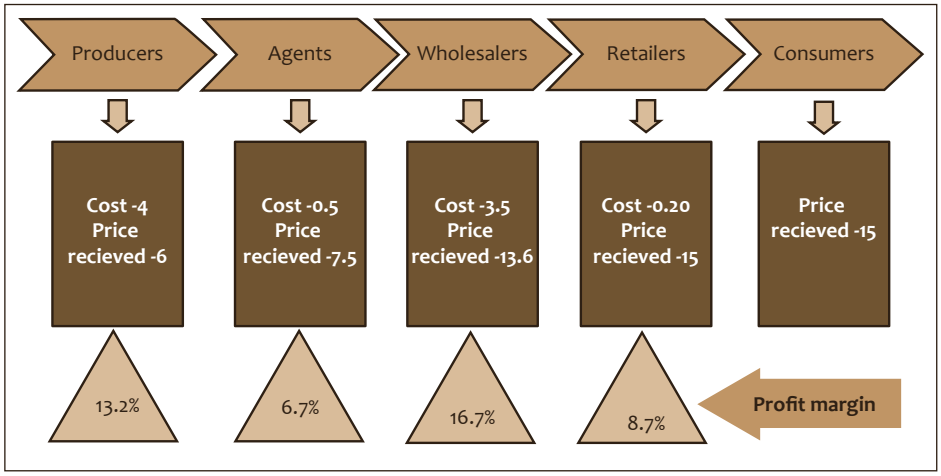

Figure 21: *Percentage profit margins along the charcoal value chain*

Source: Author's construct, 2013

The price spread for a 50kg bag of charcoal from the point of the producer to the point of consumer is GH¢ 9 which is 60% of the consumer price. It is clear that as the charcoal moves from producer to each level of actor there is a price change, as a result of cost incurred during value addition. Price rise along the actors results in the higher price of the charcoal.

According to Riçerca Cooperazione (2011), the charcoal business operates at low costs and there are not exceedingly high profits in any of the links of the chain. Shiverly *et al.,* (2010) reports that the greatest overall returns to participation in the charcoal value chain in Uganda are found among traders with returns correlating positively with their scale of activity.

3.4 **Conclusions**

The survey reveals charcoal forms an important source of income to different people involved in the chain. Overall, the profit is high on the part of the wholesalers with 16.7% of the total profit margin compared 13.2% for the charcoal producer. Given the informal and unstructured nature of charcoal business reliable estimate of the people employed in this sector is not available. Despite the existence of considerable potential and a steady growth in demand of charcoal over the last decade, the development of the Ghanaian charcoal value chain appears to be hindered by a number of problems such as unavailability of trees, poor road network and poor transport systems.

The value chain approach provides a useful and convenient tool for problem analysis, strategic and operational planning as well as implementation and monitoring. Establishment of woodlots, development of adequate credit facilities and building cooperative among transporters and marketers of charcoal would ensure smooth flow along the chain and therefore must be examined. Moreover effective and comprehensive straightforward approach that recognizes the interdependencies between the different segments in the charcoal chain as well as the multitude of dimensions like technologies, economics, environmental and social will be the best and most successful way to promote charcoal the value chain in Ghana.

4 FINANCIAL ANALYSIS OF CHARCOAL PRODUCTION SYSTEMS

Summary

Charcoal production undoubtedly contributes to deforestation in Africa. In Ghana, a program to promote charcoal production from sustainable wood sources as alternative livelihood for illegal chainsaw millers is being proposed. However, there is limited knowledge on the economics of charcoal production and associated environmental impact. This study assessed the viability of three charcoal production methods using the financial cost-benefit methodology. Descriptive and input-output data was gathered from three types of charcoal producers using the traditional earth mound, brick and metal kiln technologies. Ninety-nine percent of the producers used the earth mound technology relying on wood from a wide range of tree species in natural stands (forest, farms and fallow lands) while the remaining 1% used wood from planted woodlots of Cassia siamea and Eucalyptus.

Results indicate that charcoal production irrespective of wood source and technology is profitable at the prevailing agricultural and forestry lending rate of 22% in Ghana. There were considerable differences in production conditions among the three charcoal burning methods. However, production with the metal kiln returns the highest profit with Net Present Value of GH¢14,000 compared with GH¢5,800 and GH¢2,400 for the brick and earth mound respectively when wood is purchased. Similarly, the NPV for production from Eucalyptus woodlot with the metal kiln of 7ft capacity was higher i.e. GH¢545,524 while that for the Cassia woodlot with the brick kiln of 4ft capacity was GH¢52,053. However, profitability declines considerably with increases in production cost.

One of the key challenges aside health risks, confronting the charcoal production enterprise according to producers, is the decline in desirable tree species for charcoal burning. Thus, although production is generally profitable, a program to promote sustainable charcoal production among displaced illegal chainsaw lumber millers would need to put in place a parallel program for the establishment of short rotation woodlots purposely for charcoal production. Anogeissus is the most desired species from natural stands for charcoal burning due to its good burning properties. However, plantations of shorter rotation species of Cassia

siamea have equally proven to be ideal for charcoal burning. A rotational woodlot system may be considered to ensure continuous production throughout the year.

4.1 **Introduction**

The contribution of charcoal to energy requirements particularly for countries in Sub-Saharan Africa is widely acknowledged. In Ghana its contribution to food security, employment and cash income cannot be over emphasized. As indicated in earlier chapters, charcoal production and marketing is an age old industry with a considerably high demand for the product in developing countries and also globally. Thus although, contributes to environmental degradation, charcoal production in recent discourses is being considered by development institutions for addressing poverty and environmental problems. Riçerca Cooperazione (2011) is of the view that charcoal production in Ghana can be transformed to serve as one of the best strategies to curb the desertification process in the country while alleviating poverty particularly in predominant charcoal producing areas. However, there is limited empirical knowledge on the economics of charcoal production systems in the country to guide policy decisions on promoting this enterprise. FAO conducted general studies costing various models of charcoal production and marketing on commercial basis (FAO, 1985). Monela, *et al*., (1993), Louga, et al., (2000) and Murerehe and Richter (2011) among others have also studied various economic aspects of the charcoal industry in East Africa. There is little or no information on the economics of charcoal production systems particularly to guide investment implications in this sector in Ghana.

This study forms part of a background empirical analysis on the charcoal industry in support of the alternative options to illegal chainsaw lumber milling in Ghana. It is aimed at understanding the basic economics of expected streams of costs and revenues to assess the viability of the charcoal enterprise as well as its employment generation potential. The information produced is also critical for informing decisions on the promotion and adoption of such intervention among policy makers and other practitioners interested in promoting charcoal production particularly in support of poverty alleviation.

4.2 **Objectives and scope of the study**

The main objective of this study is to assess the financial viability i.e. the costs and benefits associated with the charcoal production enterprise in Ghana. The study specifically addressed the following questions:

1. How viable is charcoal production as an enterprise with available technologies and what are the investment implications?
2. How viable is charcoal production from woodlot or wood fuel plantation?
3. What are the implications for promoting charcoal burning among illegal chainsaw millers

This chapter covers the following:

1. A description of the charcoal production process in five selected districts in Ghana based on three main technologies surveyed i.e. traditional earth mound, brick kiln and metal kiln systems
2. The viability of producing charcoal with these technologies using the financial cost-benefit analysis methodology to estimate cost and benefit streams i.e. cash flows, Benefit-Cost Ratio (B/C ratio) and Net Present Value (NPV). The sensitivity of the profitability to changes in the yield of charcoal and cost of production has also been determined.
3. The financial viability of charcoal production from established wood fuel plantations or woodlots
4. Implication for promoting charcoal burning among illegal chainsaw millers

4.3 **Methodology**

4.3.1 Study sites

The data for the financial analysis of charcoal production systems was collected from 5 purposively selected districts, i.e. Ejura Skeyere Dumasi (Ashanti-FST), Mpohor-Wassa East (Western-Wet Evergreen Forest), Afram Plains (Eastern-FST), Efutu (Central-Costal Savannah) and Akatsi (Volta-Coastal Savannah) (Figure, 2). The sites were selected to capture the use of the three main technologies employed in charcoal production in the country i.e. earth mound, brick and metal kilns by a wide range of producers (subsistence, commercial

and exporters). Wood for charcoal production is often sourced from the natural vegetation. There are very few cases of charcoal production from established woodlots. Two sites i.e. Akatsi and Winneba were visited mainly to gather data for the plantation production analysis.

All districts surveyed are typically agrarian economies with agriculture engaging up to 80% of the labour force (www.ghanadistrcits.com). Agricultural production is largely rain-fed and practiced under slash and burn with relatively low external inputs. Charcoal production is frequently undertaken as a secondary activity by most households in farming communities in these areas on subsistence basis to supplement income from agriculture. However, there are other producers who engage in charcoal production on commercial basis.

4.3.2 Data collection and analysis

4.3.2.1 Respondents

Charcoal producers using the traditional earth mound, metal kiln and brick kilns were the key respondents interviewed for the financial analysis using structured and unstructured questionnaire as well as focus group discussions.

4.3.2.2 Input and output data

Detailed input-output data was collected on traditinal earth mound, earth brick kiln and metal kiln charcoal production technologies/systems surveyed. Similar data was also collected for charcoal production under woodlot/plantation systems. Input costs and output prices were estimated at market rates based on the sequence of activities undertaken in charcoal production for each technology (Fgiure 2). Inputs and outputs under plantation production were based on charcoal produced with:

- Earth Brick from *Cassia siamea* woodlot established and manged by a private charcoal producer at Akatsi, Volta Region.
- Metal Kiln from eucalyptus woodlot established by the Forest Services Division and being harvested for charcoal production by an exporter at Winneba, Efutu municiapl in the Central Region.

Plate 3: *Inteviweing cassia plantation producer-Akatsi, Volta Region.*(Photo by Daniel Geraldo)

Estimates were made per production cycle and projected over the number of cycles per month and then over a year. The data sheets used for collecting the information from producers are attached in Appendix 1.

4.3.2.3 Costs & benefit streams estimated for charcoal technologies and production from woodlots

I. The cost & return items estimated from charcoal production irrespective of source of wood are as follows:

A. Capital costs

1. Production equipment –Earth pit, brick and metal kilns
2. Infrastructure –shed or housing for kiln

B. Recurrent/variable costs

1. Wood
2. Other production materials/consumables (including packaging costs) - cutlass, grass, soil, fire, rake, bags
3. Labour for production & packaging
4. Transportation costs –wood to production site & charcoal to roadside
5. Marketing: tax, waybills, permits etc.

6. Depreciation costs on production equipment
7. Repair and maintenance of production equipment

C. Revenue/returns

Total revenue was estimated from the product of number of bags of charcoal produced cycle/month/annum and market price at production site.

II. Cost and return items estimated for plantation establishment and management

A. Fixed costs

1. Land
2. Shed or resting place

B. Recurrent

1. Tools (cutlass, chisel, spraying machine, etc.)
2. Protective wear (Wellington boots, etc.)
3. Planting materials i.e. tree seedlings, seeds of food intercrops planted in the first 1- 2 years to take advantage of the soil rent on clearing of vegetation for woodlot establishment
4. Herbicides for weed control
5. Labour for land preparation, planting, maintenance and harvesting of wood

C. Revenue/returns

Total revenue was estimated from quantity of wood harvested per hectare

Direct costs in charcoal production under all the three technologies include raw materials, labour, marketing and equipment. There is no fixed cost incurred on capital equipment under the traditional earth kiln system. The brick and metal kilns require a substantial sum of capital to be invested for their construction. The straight line depreciation method is used to depreciate both the brick and metal kilns over their productive life span as follows:

Depreciation = (Cost of asset-Salvage value)/Life span of the asset

The life span of the brick kiln =10 years and salvage value = 0

The life span of the metal kiln =12-15 years and salvage value = 0

The value of wood as a raw material for charcoal production was obtained through the prevailing market rate for selling a bundle of fuel wood. The prevailing labour i.e. by day rate was used as the price of hiring a labour in charcoal production. In certain period of the year especially during the raining season charcoal production competes with subsistence farming for labour.

Direct benefits consisted of revenues received from the sale of charcoal, while net revenue was calculated as the difference between annual revenue and cost under each charcoal production system. Due to the time value of money, discounted methods were used to enable the comparison of future cost and benefit with present values.

4.3.2.4 Data analysis

4.3.2.4.1 Financial viability of charcoal production with technologies and from plantation production

The scale of analysis used was at the individual charcoal producer or entrepreneur level. There are various analytical methods in determining project viability in the field of investment analysis but the most used of these methods is the cost-benefit analysis. Cost-benefit analysis (CBA) is a practical and rigorous means of assessing an investment's worth among alternatives. Information from CBA attempts to establish the most effective allocation of resources, when determining whether a specific project or program should be undertaken or when selecting the most optimal alternative among a set of options (European Union, 2008). Piyaluk (2001) indicated that projects with longer life, spanning more than one year has its cost and benefit occurring at different periods throughout the project life. In order to make all values compatible with respect to time, they need to be adjusted to present values (present worth) by discounting.

Consequently, a financial cost-benefit analysis has been undertaken to demonstrate the profitability of the charcoal production enterprise based on technology i.e the traditional earth mound kiln, brick kiln (4ft capacity) and metal kiln (7ft capacity) using costs and revenues estimated from the input-output data from 3.2.1 above. Cashflows indicating yearly costs and benefit streams have been estimated at three levels as follows:

- Production over cycles per annum for the traditional, brick and metal kiln technologies assuming wood is purchased

- Production over cycles for the traditional, brick and metal kiln producers over 10 year production period equivalent to the life span of the brick kiln assuming wood is purchased.
- Production per ha from cassia and eucalyptus plantations over 25 years for brick kiln of 4ft deep and 35 years for the metal kiln of 7ft deep respectively. FAO 1985, indicates that if the charcoal enterprise is to establish plantations for wood supply, then it is necessary to extend the financial projection till the plantation has gone through a complete rotation, involving replanting which could be twenty years or more.

The cashflows have been discounted at the real/market lending rate of 22% for agricultual and forestry investments in Ghana (www.agricbank.com, 2013) to assess the worth/profitability of these systems. Profitability indicators estimated were Benefit-cost Ratio (B/C), Net Present Value (NPV) and IRR. The decision criteria for profitability are summarized in Table 10. The charcoal system is profitable if BCR ≥ 1, NPV ≥ 0 and IRR = r. r is the interest rate used in discounting (Table 10).

Table 10: *Profitability indicators*

Economic tools	Formula	Decision Criteria
B/C Ratio	$\frac{\sum B_t}{(1+r)^t} \div \frac{\sum C_t}{(1+r)^t}$	BCR ≥ 1.0
NPV	$\sum_{t=0}^{t=n} \frac{(B_t - C_t)}{(1+r)^t}$	NPV ≥ 0
IRR	$\sum_{t=0}^{t=n} \frac{(B_t - C_t)}{(1+r)^t}$	IRR ≥ r

B = benefit,
C = cost,
t = time in year or production period,
r = discounted rate,
n = length of production period in years

The sensitivity of the profitability of the charcoal enterprises to increases in cost up to 50% in the worst case scenario and decline in charcoal output up to 20% has been estimated. This is based on the premise that cost of goods and services used in production rise annually as a result of year on year inflation,

indicated by the Producer Price Index (PPI). It is also to take care of contingent expenses and other costs that could not be estimated by producers for instance shed or housing for brick and metal kilns, etc. Moreover, the quantity of charcoal produced per cycle or hectare depends of the quality (density, moisture content, etc.) of wood, management of the carbonization process and conversion efficiencies of the kilns. Thus charcoal yield is subject to reduction from the normal production turnover recorded in the field, if these factors are not carefully managed. Indeed, *"if kilns are not operated correctly, yields can be half the optimum level"* (Practical Action, undated).

4.4 Results and discussion

4.4.1 Charcoal production context

4.4.1.1 Profile of charcoal producers

Both women and men play a role in charcoal production although it is primarily viewed as a men's occupation. Eighty percent of the charcoal producers interviewed were males and 11% were females. Charcoal production is a male dominated occupation as most of the activities associated with its production require physical energy and is labour intensive making it not well suited for females. The mean age of the charcoal producers was 37 years, ranging between 18 and 70 years. This indicates that most charcoal producers are in their prime age. Forty-eight percent of the traditional producers are not formally educated while the majority of the remaining 52% who are literate have had basic education. The average family size of charcoal producing households is 6. Overall, 35% of the producers are largely engaged in charcoal burning as their main source of livelihood while 64% are subsistence producers mainly involved in crop farming (Figure 22).

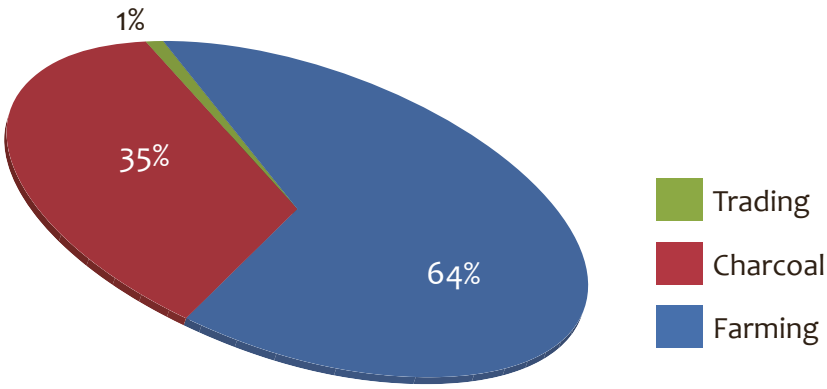

Figure 22: *Major occupation of charcoal producers*

Most charcoal producers use the traditional earth kilns. Although the brick and metal kilns may be more efficient, majority of the traditional producers have hardly been exposed to these improved technologies. The initial capital outlay for acquisition of the brick and metal kilns deterred a few of the producers who were aware of these technologies from using them.

4.4.1.2 Sources of wood resource, access and availability for charcoal burning

A greater proportion of the wood used in burning charcoal is acquired from farms and fallow lands outside reserved forests. Thus 64% of the charcoal producers interviewed secured their wood raw material from their own farms whereas 21% collected wood from the forest and 14% depended on both farm and forest supplies, supplementing collection from their farms with that from the forest. Only 1% of producers interviewed used wood from plantation for charcoal production as this practice is not common among traditional earth mound producers (Figure, 23). However, there are some known cases of *Cassia* rotational woodlots for charcoal burning along the coastal zone of the Central Region.

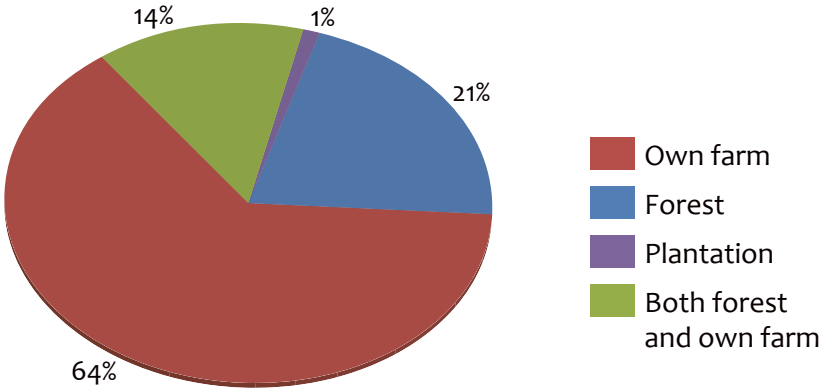

Figure 23: *Sources of wood for charcoal burning*

Apart from those using wood from plantations for charcoal burning, most charcoal producers interviewed especially in the Ejura Sekyere Duamse district did not pay for wood they used for charcoal production. However, some producers in the Afram Plains that harvest wood from land owned or secured by others for farming and other purposes pay 20 out of every 100 bags of charcoal produced to resource owners as the cost of wood.

Over 40 tree species used for charcoal were recorded during the survey. The first 20 frequently used species are presented in Table 11. Kane (*Anogeissus leiocarpus*) is the common species used, which confirms review on charcoal species in Table 4. The respondents indicated a decline in the availability of tree species used for charcoal production. This they attributed to the rising number of charcoal producers and growing demand in charcoal consumption. Ultimately, this is contributing to the decline in charcoal supply. Seventy percent of the respondents involved in charcoal marketing confirmed that the supply of charcoal has declined consistently over the years.

Table 11: *Tree species used for charcoal by traditional producers in study areas*

No.	Local name	Scientific name	% of cases
1	Kane	*Anogeissus leiocarpus*	20
2	Potrodom	*Erythrophhleum ivorense/guineensis*	15
3	Kranku	*Vitellaria paradoxa*	11
4	Krayie	*Pterocarpus erinaceus*	10
5	Sakanea	-	7
6	Senya	*Daniellia oliveri*	7
7	Mahogany	*Khaya spp*	5
8	kwagyedu mmpaboa	-	4
9	Angwa	-	2
10	Pepea	*Margaritaria discoidea*	2
11	Gmelina	*Gmelina arborea*	2
12	Dawadawa	*Parkia spp*	1
13	Adanko mpaboa	-	1
14	Brakanka	-	1
15	Teak	*Tectona grandis*	1
16	Mango	*Mangifera indica*	1
17	Neem	*Azadirachta indica*	1
18	Papao	*Afzelia africana*	1
19	Petepre	-	1
20	Ngo dua	-	1

4.4.1.3 Charcoal production process and technologies

As indicated above, three main charcoal production systems or technologies were identified during the field visits, i.e. the metal kiln, brick kiln and the traditional earth kiln (Plate 4). All these three systems are used for commercial charcoal production; the traditional earth kiln is the most used and common amongst all the respondents. The charcoal production process begins with tree identification if wood is to be secured from the natural forest (Figure 8.). Suitable trees are earmarked and harvested over a period of time. The wood

may be dried for a maximum of 5 days or less depending on the thickness of the tree and moisture content. The dried wood is then sorted by diameter and stacked next to the burning site after which the production process varies with the type of technology used (Plate 4).

Traditional earth mound

Earth brick kiln

Metal kiln

Plate 4: *Technologies used for charcoal production in Ghana analyzed*

Table 12: *Key features of charcoal technologies analyzed*

Feature	Traditional Earth Mound	Brick kiln	Metal kiln
Description	Dug out pit packed & covered with grass and soil	Mud brick oven	Cylindrical metal oven
Size	Unknown	4t round	7ft deep
Life span (years)	1 cycle	10	12-15
Conversion efficiency %	14 - 20	-	-
Production duration (days)	10-15	3-4	3-4
No. of production cycles per month	1-2	3	6
Cost (GHç) (depends on size & quality)	labour for digging trench	1,500	6,000
Production turn over (per cycle) in mini bags (20-22kg)	4- 10	9	40
Major limitation	Health (Smoke, burns) Ash, laborious	Initial equipment cost	Initial equipment cost

Traditional earth mound kiln/technology

After collection, the wood for the charcoal is stacked next to the burning sites; the wood is then stacked into a dug-out earth pit or heap on a relatively flat plain up to a reasonable height and covered with a layer of grass/ leaves and sand. A heap of sand is then gently used to cover the entire heap leaving two very small openings for fire to be lit and smoke exit. The fire is then lit from the opening. After the entire woods/logs catch fire the hole is sealed with small sticks and grasses. The process is then closely monitored both day and night for about 5-8 days, depending on the size and moisture content of the wood during carbonizing. The logs burn into the required charcoal gradually. Vents are created in each earth mound to allow proper ventilation and continued burning.

Wood packed at production site after harvesting and collection

Stacking wood after collection

Covering wood with grass

Setting and monitoring fire

Raking charcoal and bagging

Charcoal bags packed at the road side

Plate 5: *Traditional earth mound charcoal production process*

Depending on the size of the wood and height of the heap, the burning takes up to a week. If the earth kiln is not vented properly, it can either smother the fire before carbonization takes place or burn too hot, causing over burning, leaving only a pile of ashes. The process of carbonizing is completed when it stops smoking and cools. In the process of cooling the carbonized wood are watered to facilitate the cooling. At this point, the charcoal producer begins raking and separating the dirt and debris from the newly formed charcoal. Using the traditional kiln for charcoal production is labour intensive and mainly

carried out by mostly men. These initial activities like felling, crosscutting, piling and stacking of logs requires high manual labour inputs which is more than 50% of the total labour requirement for charcoal production from one traditional earth kiln.

Brick kiln

This varies slightly from that of the earth mound kiln. After the wood for the charcoal is stacked next to the kiln, the wood is then arranged in the kiln till the kiln becomes full, this requires technical knowhow. Fire is then set into the piled wood, as some of the vents are closed just one or two is open to control the fire. After 12-15 hours of burning, all the open vents are sealed to for the kiln to cool down. Charcoal is then raked out from the brick kiln and sorted out and bagged. Although improved technology over the earth mound (because burning site is restricted), it needs to be constantly maintained and because it is immobile, wood has to be conveyed from a distance to the production site.

Metal kiln

The variation between the metal kiln and that of the brick is that the metal kiln of course is made of steel and is mobile unlike the brick kiln which is made of mud/laterite and is stationary or immovable. After the metal kiln has been assembled together, the wood for the charcoal is then arranged in the kiln till the kiln becomes full, this requires technical knowhow. The metal kiln is covered with its cap, with vents in the cap; fire is lit through the opening in the cap into the piled wood. Some of the vents are closed just with one or two opened to control the fire. After 10-12 hours of burning, all the open vents are sealed to for the kiln to cool down. The metal kiln is then disassembled so as to get access to the burnt charcoal. Charcoal is then raked out from the pile, sorted and bagged.

4.4.1.4 Challenges/constraints in charcoal production

Producers using the earth mound technology listed a number of factors constraining charcoal burning (Figure, 24). Most importantly, the production process is laborious and is associated with burns. Also dust from the sand used to cover wood during carbonization as well as smoke from the burning wood often blow into the eye and also inhaled, casing eye and chest problems. Moreover, suitable tree species used for charcoal have declined in supply.

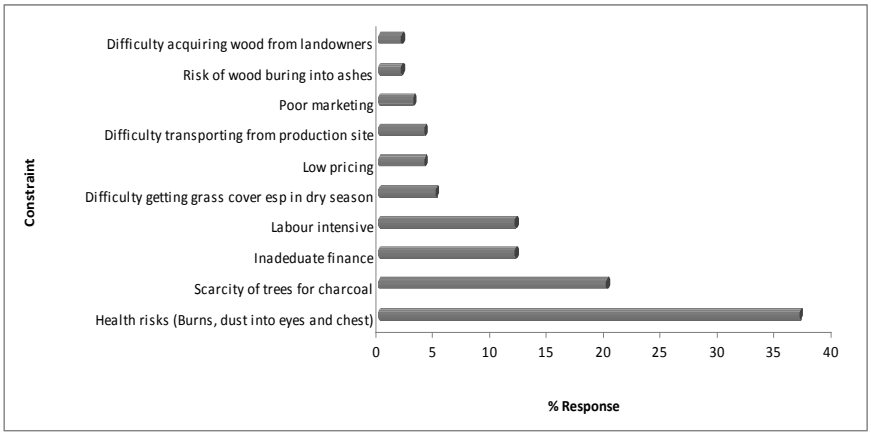

Figure 24: *Constraints in charcoal production*

4.4.2 Financial viability of the charcoal enterprise

4.4.2.1 Cash flows: Costs and returns from charcoal production

Tables 5 and 6 present the summary cash flows i.e. expected costs and returns from charcoal production using the three production methods/ technologies in Ghana. The cash flow covers fixed, operation costs and marketing costs and revenue from charcoal output sold in bags of 20kg (mini bag) or 40kg (maxi bag) per annum and over10 years. Although the three technologies were used under varied production conditions, the positive net revenue or cash flow for all the three technologies indicates that charcoal production under these technologies is viable over both short and long term.

Table 13: *Summary cash flow for earth mound, brick kiln and metal kiln per annum*

Items	Charcoal production technology		
	Traditional earth mound (unknown volume) (Subsistence)	Brick kiln of 4ft deep capacity (Domestic commercial)	Metal kiln of 7ft deep capacity (Exporter)
Revenue (GH¢)			
Charcoal	4,488	5,238	51,840
Total revenue	**4,488**	**5,238**	**51,840**
Costs (GH¢)			
Fixed			
Kiln usage per annum		150	500
Shed	-	-	-
Recurrent/variable			
Wood	600	1,080	21,600
Tools	22	22	44
Packaging bags	73	120	1,440
Labour for production	2,490	2,148	19,648
Marketing	431	420	7,068
Total cost	**3,616**	**3,940**	**50,300**
Net Revenue	872	1,298	1,540
Labour % total cost	69	55	39
Wood % total cost	17	27	43

The metal kiln returns the highest profit with the least percentage of labour to total cost. The earth mound has a lowest capital outlay but relatively high labour cost, thus incurs the highest percentage of labour to total cost. The highest revenue obtained for the metal kiln is as a result of the higher production capacity and frequency of production per cycle. While the average production capacity of the earth mound is unknown, that for the brick is 4ft deep compared with the metal kiln with a capacity of 7t. Moreover, the

number of production cycles is once per month for the earth mound compared to thrice per month for the brick and six times for per month for the metal kiln.

Table 14: *Summary cash flow for traditional earth kiln, brick kiln and metal kiln (10 years)*

Items	Charcoal production technology		
	Traditional earth mound-unknown volume (Subsistence)	Brick kiln of 4ft deep capacity (Domestic commercial)	Metal kiln of 7ft deep capacity (Exporter)
Revenue (GH¢)			
Charcoal	36,554	57,618	570,240
Total revenue	**36,554**	**57,618**	**570,240**
Costs (GH¢)			
Fixed			
Kiln	-	1,500	6,000
Shed	-	-	-
Recurrent			
Wood	3,960	9,900	237,600
Kiln depreciation		1500	6000
Tools	242	242	484
Packaging bags	802	1,650	15,840
Labour for production	19,902	13,200	141,108
Marketing	8,357	7,590	118,140
Total cost	**33,262**	**34,082**	**519,172**
Net Revenue	3,292	22,036	45,068
Labour % of total cost	60	37	27
Wood % total cost	12	28	45

4.4.2.2 Charcoal enterprise worth

The discounted cash flow results presented in Table 15 show that all the three charcoal production systems in Ghana is generally profitable at 22% percent

discount rate. However, the traditional earth kiln system is the least profitable among all the production system with NPV GHç 2,417.0 The metal kiln is the most profitable with NPV of GHç 14,088.0; followed by the brick kiln with NPV of GHç 5,817.0.

Table 15: *Discounted cash flow per annum and over 10 years at 22% discount rate*

Profitability indicator	Earth mound	Brick kiln	Metal kiln
Production per Annum			
Benefit/Cost Ratio (BCR)	1.24	1.37	1.04
Net Present Value (NPV) GH¢	488	453	570
Production over 10 years			
Benefit/Cost Ratio (BCR)	1.11	1.30	1.10
Net Present Value (NPV) GH¢	2,417	5,817	14,088

Sensitivity of profitability to changes in production parameters

Table 16 shows the sensitivity on variation of some parameters over 10 years of production. The results indicated that the charcoal production enterprise is very sensitive to increases in cost. 10% rise in cost of production adversely renders the enterprise unprofitable. Also a reduction in charcoal yield or the unit price of charcoal by 20% caused a decline in profitable of charcoal production under the three systems with each showing a negative NPV.

Table 16: *Sensitivity to increases in production costs and decreases in charcoal output*

Profitability	Earth mound		Brick kiln		Metal kiln	
	BC Ratio	Net present value (GH¢)	BC Ratio	Net present value (GH¢)	BC Ratio	Net present value (GH¢)
Base	1.1	2,417	1.3	5,570	1.1	14,088
Cost increases 5% and yield decreases 5%	1.2	3,541	1.2	3,857	1.0	1,471
Cost increases 10% and yield decreases 5%	1.1	2,710	1.1	2,886	1.0	-687

Profitability	Earth mound		Brick kiln		Metal kiln	
	BC Ratio	Net present value (GH¢)	BC Ratio	Net present value (GH¢)	BC Ratio	Net present value (GH¢)
Cost increases 10% and yield decreases 10%	1.1	1,605	1.1	1,610	1.0	-11,147
Cost increases 20% and yield decreases 10%	1.0	-56	1.0	-332	1.0	-15,463

4.4.2.3 Profitability of charcoal production from woodlots

Results presented in Table 17 indicate that charcoal production from both cassia and eucalyptus woodlots/plantation is profitable at prevailing lending rate of 22% with the brick and metal kilns respectively. However, profitability is sensitive to increases in production cost. For the brick kiln, 20% increase in cost renders the enterprise unprofitable while 20% decline in charcoal output makes profit marginal (Table 17).

B Plantation production with the brick kiln is unprofitable when costs increases and charcoal output declines by 10% simultaneously. Plantation production with the metal kiln remains profitable until production cost increases to 50% and charcoal output declines by 20% simultaneously (Table, 18).

Table 17: *Cash flow and profitability of charcoal from plantation production /woodlots per ha*

Cash flow	Brick kiln (cassia)	Metal Kiln (Eucalyptus)
Revenue		
Food crop		
Maize	1,200	1,600
Cassava	500	1,200
Pepper	3250	-
Okro	500	-

Table 17 (cont): *Cash flow and profitability of charcoal from plantation production /woodlots per ha*

Cash flow	Brick kiln (cassia)	Metal Kiln (Eucalyptus)
Charcoal	114,048	1,607,040
Total Revenue	119,498	1,609,840
Costs		
Plantation establishment, maintenance		
Land	2000	2,000
Tools (cutlass, hoe, chisel for digging, wheel barrow, watering can)	573	858
Protective clothing (Wellington boots)	780	1,050
Labour (land preparation, planting, weeding, creation of fire belt & maintenance, harvesting and processing maize)	6,736	5,044
Maize seed & tree seedlings	342	342
Transporting seedlings	250	150
Managing plantations	-	14,000
Charcoal production		
Equipment & tools		
Kiln	3,000	12,000
Kiln depreciation	3,000	11,600
Shed	100	
Rake & cutlass	528	744
Labour for production (harvesting wood, collection, packing near site, cutting into pieces, stacking in kiln, monitoring fire, cooling, raking out charcoal, packing into bags, loading at site and off loading at road side)	55,851	552,048
Packaging bags	4928	6944
Marketing (transporting to the road side)	3520	178560

Cash flow	Brick kiln (cassia)	Metal Kiln (Eucalyptus)
Market levy	4928	
Total cost	86,535	785,340
Net Revenue	32,963	824,500
Benefit/Cost Ratio (BCR)	1.16	1.83
Net Present Value (NPV) GH¢	2,053	45,524
Financial/Internal Rate Return) IRR %	66	98

Table 18: *Sensitivity to increases in costs and decreases in charcoal output from plantation production*

Profitability	Brick kiln (cassia)			Metal kiln (eucalyptus		
	BC Ratio	Net present value (GH¢)	IRR%	BC Ratio	Net present value (GH¢)	IRR%
Base	1.2	2,053	66	1.8	45,524	98
Cost of production increases						
10%	1.1	747	35	-	-	-
20%	1.0	-558	18	-	-	-
50%	-	-	-	1.2	12,070	54
Charcoal output decreases						
10%	1.1	1,064	51	-	-	-
20%	1.0	75	27	1.5	26,071	81
40%	-	-	-	1.1	6,296	46
50%	-	-	-	0.9	-3,591	4
Cost increases and output decreases						
Cost increases 5% and output decreases 10%	1.0	411	33	-	-	-
Cost increases 10% and output decreases 10%	1.0	-242	21	-	-	-
Cost increases 10% and output decreases 20%	0.9	-1230	-!	-	-	-
Cost increases 40% and output decreases 20%	-	-	-	1.1	3,854	34
Cost increases 50% and output decreases 20%	-	-	-	1.0	-1,701	21

4.5 **Conclusions**

The economics and environmental impact of charcoal production has hardly been studied in Ghana. This study has analyzed the costs and benefits associated with charcoal production based on three technologies used in the country. Generally, production is done largely by males in their youthful age with a mean age of 37. Production is done on both subsistence and commercial basis. Thirty-five percent of the producers interviewed in this study engaged in the enterprise as their major source of income. Four key constraints to charcoal production are health risks (accidents from burns and dust into eyes and chest), scarcity of trees for burning charcoal, laboriousness of the production process and inadequate finance for production. Poor financing often leads to buyers offering lower prices for charcoal produced. Respondents indicate that the scarcity in wood for charcoal burning has resulted in a consistent decline in charcoal supply to the market. This is as a result of the rising number of charcoal producers and market demand for consumption.

Charcoal production irrespective of technology is profitable at 22% discount rate i.e. prevailing real interest rate for lending to agricultural and forestry projects in Ghana. However, profitability is quite marginal and very sensitive to decreases in charcoal output. Benefit Cost Ratios were quite low i.e. 1.1, 1.3 and 1.1 for the earth mound, brick kiln and metal kiln respectively when wood was paid for.

5 FEASIBILITY OF CHARCOAL PRODUCTION AS AN ALTERNATIVE LIVELIHOOD IN CHAINSAW DEPENDENT COMMUNITIES

Summary

This aspect of the study analyzed chainsaw actors' perception of the feasibility of charcoal production and supply as an alternative livelihood option to illegal chain sawing in three selected communities in the Sunyani Forest District using focus group discussions.

Findings indicate that chainsaw prevalent communities are mainly agrarian with the majority involved in farming. Charcoal production is practiced as a secondary occupation. Production is seasonal, thus although there is demand for the product by middlemen or traders, current supplies cannot meet expected demand throughout the year.

Charcoal production will compete favourably with other forest based activities for wood resources and labour. Wood resources in the communities are declining as land for farming is urgently required. At the moment land is not easily available for establishment of plantations as community land areas are constrained by boundaries of forest reserves. However, potential sources of wood for charcoal identified included logging residues, farm clearings, suitable species on fallow lands and dead wood on farms and fallow lands.

At Atronie, 56% of respondents were willing to switch from chainsaw to charcoal production and supply. However, only few were interested in actual production because the process is tedious. More people wanted to be involved in planting woodlots for charcoal production. There has been some move by chainsaw actors in Asuakwa to engage in charcoal production using logging residue from teak, farm clearings.

Overall, communities were willing to switch but requested for training and organization in groups to facilitate this process. Wood raw material for burning charcoal is the greatest challenge that will restrain the charcoal idea. However, communities suggest that woodlots of teak, neem, cassia and other fast growing short rotation species may sustain production and also not to worsen

deforestation. Nevertheless, extra efforts need to be made to secure suitable land for charcoal woodlots.

5.1 Introduction

Tropenbos International, Ghana, the Forestry Commission of Ghana and other institutions have been considering the concept of artisanal milling as a policy option for legal lumber supply to the domestic timber market in Ghana. It is anticipated that this policy when in operation will displace a segment of illegal chainsaw lumber producers from business. Displaced illegal chainsaw millers who cannot meet the requirements of the new policy option may require to be settled in lucrative alternative income activities. Charcoal production is being considered as one of the options for addressing livelihood needs of displaced illegal chainsaw producers.

The demand for charcoal is high in the country despite the introduction of alternative sources of energy such as LPG. Charcoal production is the main source of energy for cooking in households, the service industry and also for industrial purposes. The enterprise is identified as a lucrative livelihood option and major source of supplementary income to rural households (ESMAP, 2006), despite being a driver to deforestation. Tropenbos International, Ghana and its partners seek to explore the potential of sustainable charcoal production as an alternative income source in chainsaw prevalent communities.

5.2 Objectives

The main objective of this aspect of the study emanates from the broad theme of building an understanding of the context of the production, supply and consumption of charcoal and related economics in Ghana as well as the implications for promoting charcoal production as a viable enterprise in selected chainsaw milling communities to safeguard their livelihoods while ensuring environmental or ecosystem sustainability. The key research question addressed was:

- Will it be feasible to switch illegal chainsaw lumber milling for charcoal production and supply in chainsaw prevalent communities?

The specific objectives of the study were:

1. To assess the perceptions of illegal chainsaw actors of the possibility of the switch in job i.e. charcoal for illegal chainsaw
2. The availability and accessibility of the productive resources (wood, land, labour, financial capital, etc.) and market potential for charcoal in the communities

This chapter covers the following:

- Forest and other livelihoods pursed in study communities
- How will charcoal production compete or compliment these activities
- Potential wood raw material sources and availability for charcoal
- Tenure –access to resource (trees and land)-institutional arrangements for access and use
- Land availability and the potential for charcoal forests/woodlot development Availability of capital for the charcoal enterprise
- Willingness and interests of chainsaw people to go into charcoal production
- Aspects of the chain actors are willing to participate in (raw material production, processing, marketing, etc.)
- Existing charcoal marketing strategies
- Potential environmental and socio-economic impacts of charcoal production
- Potential barriers or challenges and possible alleviation measures
- Implications for promotion of charcoal production at the project sites

5.3 **Methodology**

Participatory rapid appraisal methods were employed to collect data from three selected chainsaw milling communities on the fringes of some forest reserves in the Sunyani Forest District. Focus group discussions were held with different chainsaw stakeholders in the three selected communities (Table 19). The stake holders in each community comprised of chainsaw operators, community elders, carriers, existing charcoal producers, assembly men and a district forest officer of the Sunyani forest district. Besides the focus group discussions, informal interviews were conducted with key informants of the

communities surveyed. The checklist of issues investigated is attached in Appendix 2.

Table 19: *Stakeholder groups considered for focus Group discussion in communities*

Name of Community	Location (forest reserve)	Total Number of people engaged in discussion	Category of People
Atronie		17	Chainsaw Operators Community Elders Unit Committee Members Community Assembly Men Sunyani Forest District Officer Carriers Charcoal Producers Community elders
Asuakwa	Yaya forest	15	
Nsuatre		18	

5.4 **Findings**

5.4.1 Local economy of chainsaw prevalent communities

The local economies of communities visited were mainly agrarian, with some dependency on forest based enterprises. Table 2 shows the different forest and agriculture related livelihood activities in the communities surveyed. Majority of the people are engaged in farming as their primary occupation. All other sources of income are secondary and are pursued by relatively lower percentage of the people. Thus although charcoal production was indicated as an enterprise pursued in all the communities visited, very few people engaged in this enterprise.

Table 20: *Agriculture and Forest based Livelihood Activities in communities*

Name of community	Existing Agriculture and forest based livelihood Activities
Asuakwa	Charcoal production
	illegal chainsaw operation
	Grass cutter rearing
	Firewood collection
	Farming
	Poultry keeping
	Raising tree seedlings at the nursery on contract
Nsuatre	Charcoal production
	Honey production
	Firewood collection
	Palm oil production
	Gari production
	Carpentry
	Animal husbandry
	Farming
	Raising cocoa nursery for sale
	Pito brewing
Atronie	Farming
	Charcoal production
	Animal rearing
	Snail collection
	Leaf wrappers
	illegal chainsaw operation

5.4.2 Competitiveness and complementarities of charcoal with other forest based livelihoods

Although respondents acknowledged that charcoal production complements other livelihood strategies favorably, they indicated that this enterprise could

compete well with other forest based enterprises for two key resources, i.e. wood raw material and labour. Charcoal production as a major alternative livelihood option would be feasible if wood raw material can be guaranteed. Also charcoal production is a labour intensive activity, hence adequate labour is required.

5.4.3 Market potential of charcoal

Marketability of charcoal in the communities was not seen as a challenge since there is adequate demand for it by middlemen who purchase and transport the product to urban areas. However, charcoal production was perceived as a seasonal enterprise among some members of the communities and could suitably complement but not compete very well with other existing forest based enterprises for constant supply to satisfy demand throughout the year.

5.4.4 Potential raw material sources and availability

Although very few people were noted to be engaged in charcoal production, for the very few charcoal producers identified, sources and availability of raw materials most specifically the wood was in scarcity and could mostly be acquired through illegal means. Several sources are currently being explored to access wood used for charcoal production in the communities. These include the use of

- Legal and Illegal logging residues
- trees on farms
- Wood residues from farm clearing (at the beginning of the farming season)
- from established plantations

In spite of these existing wood sources, all stakeholders in the different communities considered woodlot establishment as a prerequisite to a viable commercial charcoal production. However, access to land for this purpose is a limiting factor considering the limited land availability for other farming activities. With respect to willingness to establish woodlot at the community level, respondents of the different community discussions, showed a high level of interest but suggested access to degraded patches of government reserve areas for this purpose will be essential to ensure sustainability.

5.4.5 Tenure (ownership & control over land and forest resources)

The predominant land ownership type prevailing in the communities is the family land type which is usually given out to individual family households or to migrant farmers in negotiated sharecropping arrangements. Access to tree resources and tree tenure arrangements remains the same as the governing national laws on forest resources. However, it was noted from the community discussions that trees on farms identified for charcoal burning purposes are usually negotiated at the farm owner level and fell illegally.

5.4.6 Production technologies and resource availability

The traditional earth mound method was the main technology employed by charcoal producers in the communities. The estimation of input requirement and possible turnover for the earth mound technology in other charcoal producing areas has been elaborated in Chapter 4. In spite of the limited land resources for woodlot establishment, labour and access to financial resources (savings and loans, susu facilities and credit unions) for commercial charcoal production is readily available at the community level. Marketing of charcoal was not identified as a challenge in the communities since charcoal is always in demand. In all the communities, group level was the most preferred organizational structure choice for the different aspects of the charcoal production.

5.4.7 Potential impacts

Incidence of wildfires was the primary potential environment impact outlined during the community discussions. Socio-economically, charcoal production at the community level was seen to be a viable alternative enterprise provided there is adequate raw material base for large scale production.

5.4.8 Willingness to switch from chainsaw to charcoal production

Chainsaw actors interviewed including operators, carriers and associated workers showed mixed preferences in their willingness to change from illegal chainsaw milling to charcoal production. Figure 25, indicates the level of willingness to shift to charcoal production among different categories of MSD platform members. Approximately 56% the chainsaw workers on the MSD were willing to switch to charcoal. Although majority of respondents showed some

level of willingness to change to charcoal production at the community level, a much higher interest was rather shown in the other aspect of the charcoal production value chain such us plantation of woodlots for sale, sorting and packaging as well as transporting to urban centers. Table 21 indicates the preferences of 9 chainsaw millers for their participation in various aspects of charcoal value chain. Only 2 out of 9 (22%) showed interest in engaging in the process of converting wood into charcoal.

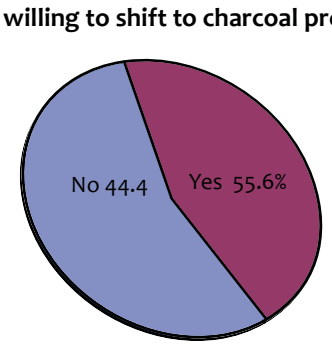

Figure 25: *Willingness to shift from chainsaw milling to charcoal production*

Table 21: *Interest in different aspects of charcoal production value chain*

Stages in Charcoal value chain	Number of respondents in a group of 9 MSD members
Marketing	9
Actual Production	2
Sorting and Packaging	5
Supply of raw materials	9

5.5 Conclusions

This chapter covered an assessment of the feasibility of charcoal production and supply in three EU-Chainsaw Project communities. Essentially, most inhabitants in these communities are farmers but some engage in other secondary income activities including illegal logging and charcoal production. Charcoal is produced by the traditional earth mound method with wood from logging residues, trees on farmlands and fallows. The product is in demand in the area for subsequent supply to urban areas. Charcoal production however, is undertaken on limited scale and is seasonal when agricultural activities

subside. There are rural capital sources that could be relied upon for financial support for any enterprise.

Chainsaw actors in the study communities are optimistic that charcoal production if properly promoted can augment livelihood strategies and serve as an alternative to illegal chainsaw lumbering. Fifty-six percent of them are willing to switch to charcoal production and supply, although majority would prefer to be involved in woodlot establishment producing raw material for charcoal production. This is because charcoal production by the traditional method is labour intensive. Chainsaw actors also indicated that the feasibility of the charcoal "idea" would be constrained by declining wood resources and limited land area for establishing large tracts of woodlot to cater for sustainable production of charcoal in these communities. Yet, they suggested establishment of woodlots of *Cassia siamea*, neem and teak to augment current wood sources for charcoal burning. Degraded patches of land in some compartments in forest reserves could be devoted to wood fuel plantations as well as planting particularly, cassia in areas designated for firebreaks and boundary lines.

6 THE WAY FORWARD FOR THE CHARCOAL INDUSTRY IN GHANA AND PROMOTION IN CHAINSAW COMMUNITIES

Summary

This chapter is a synthesis reflecting on the major issues arising from the preceding chapters as well as recommendations for the charcoal industry and its promotion as an alternative income source to illegal chainsaw lumbering.

The literature is replete with information on the importance of charcoal in the economies of developing countries and that of some industrialized nations. In many developing nations including those in Sub-saharan Africa charcoal has been produced largely for urban markets and has contributed to deforestation in these countries. Yet this industry plays a key role in energy supplies providing heat particularly for cooking and ensuring food security as well as heating industrial purposes. The demand for energy in general and charcoal continues to rise with increasing population growth in urban areas posing further threat to wood resources. However, development agents are optimistic that within the concept of the green economy desired in recent times, the charcoal industry can potentially be explored for economic and environmental benefits.

Generally, the government of Ghana and other agencies has instituted some interventions including planting of woodlots, use of Liquefied Petroleum Gas (LPG), taxes and wood fuel conserving devices to ensure efficient use of wood fuel resource but these have not achieved the desired objective. Despite these interventions there is need to address a number of concerns to ensure sustainable production and supply of charcoal to safeguard the environment and the livelihoods of the un-estimated number of actors in the supply chain as well as tap revenue for socio-economic development in the country as indicated below.

6.1 Sustainable wood fuel for charcoal production

Charcoal production is being undertaken throughout the country and especially in the savannahs where the resource is prone to adverse effect of changes in climatic conditions. With increasing demand for charcoal and declining wood resources for production, there is obviously the need for a reliable wood source

to sustain the charcoal enterprise. Also, recent concerns for green economy demands production from sustainably managed forests particularly for export markets (Riçerca Cooperazione, 2011). To ensure wood availability and to safe guard the environment, there is urgent need to promote woodfuel plantations and agroforestry in farming areas so as to create woodland resources to compensate for the depletion of natural tree species in the forest stand for charcoal production.

This study indicates that production from short rotation species plantation is financially viable even at a market lending rate of 22% for agricultural and forestry projects in Ghana. Rotational woodlot systems with short rotation fast growing species ideal for small, medium and large scale producers may be adopted as follows:

Assume a plantation model with *Cassia siamea* in a rotational woodlot system and kiln capacity of 4ft. According to the brick producer, 1 ha of cassia wood at a kiln production capacity of 4ft round will be consumed in 3 months (per quarter of the year) to produce 72 mini bags (20kg x 72 = 1440kg) of charcoal over 8 production cycles. Consequently, 4ha of cassia wood would be required at a 4ft kiln capacity to produce continuously over 4 quarters in a year. Hence, a unit producer operating a 4ft kiln capacity will require woodlot area in multiples of 4ha per annum for 4-5 consecutive years to produce sustainably. This means each unit producer will need a total of 16-20ha of land to remain full time in production sustainably (Table 22). This is because under good rainfall fall and soil conditions, cassia may take 4-5 years to mature for the first harvest of wood and the coppice growth takes at least 2 years to mature to harvest.

Table 22: *Model Cassia siamea rotational woodlot system*

Year	0	1	2	3	4
Block	Block 1	Block 2	Block 3	Block 4	Block 5
Acreage planted (ha)	4	4	4	4	4
Year	5th year	6th year	7th year	8th year	9th year
Harvest regime	Harvest block 1	Harvest block 2	Harvest block 3	Harvest block 4	Harvest block 5
Year	10th	11th	12th	13th	14th
Harvest regime	Harvest block 1	Harvest block 2	Harvest block 3	Harvest block 4	Harvest block 5

At a higher kiln capacity of for instance 8ft to increase production volume, 8ha woodlot will be required per annum. If the rotational woodlot system is to be adopted, then 8-10 ha may be planted annually for at least 4-5 consecutive years to ensure continuous supply of wood for production. A target of 30-50ha of wood need to be planted in 4-5 years and multiples of this if the expected volume of production will be higher. Displaced chainsaw millers could be assisted to plant patches of forest of short rotation species on their own land under the rotational woodlot system. Alternatively, where land is scarce, degraded patches of land in forest reserves or communal land may be secured for such large scale planting.

Some basic research and compilation of information on potential fast growing traditional or exotic species with appropriate energy characteristics that may be suitable for conversion into charcoal of appreciable burning quality is required. Silvicultural management of wood fuel resources in natural stands also need to pursued.

6.2 Charcoal production technologies and profitability

The results from the analysis indicated that at the real interest rate or bank lending rate of 22%, charcoal production under the traditional earth kiln, brick kiln and metal kiln were profitable with a lower turnover from the traditional earth kiln probably because of the lengthy production period and lower production frequency.

Although each production system operates under peculiar conditions, the study suggests that the metal kiln may be the best option or choice for charcoal production for easier management of the production process, higher production frequency, portability of the kiln, less labour intensive and possibly less health hazards compared with the brick kiln and earth mound. The metal kiln production seems best alternative to invest in for large scale commercial production if a reliable raw material supply from plantation sources can be guaranteed. It is also more expensive, than the others costing $1000 and over (Practical Action, undated) depending on the size. However, according to Van Tilburg *et al.,* (2011), more efficient kilns have multiple benefits for the producer and the environment including reduced pressure on the natural forests, reduced exposure to smoke and pollution from fires among others although remains a bottleneck for small scale producers because they require initial capital investment.

Irrespective of technology, production is sensitive to increases in production costs. Profitability was also marginal with low BC ratios i.e. 1.1, 1.3 and 1.1 for the earth mound, brick kiln and metal kiln respectively when wood was paid for. This implies that charcoal burning among displaced illegal chainsaw millers may be supported with loans at lower lending rates to enhance profitability. The World Bank suggests 10% lending rate for agricultural projects (Gittenger, 1982).

The immobility of the brick kilns increases costs of labour and haulage for loading, transporting and off-loading at the production site which may be distant away from the harvesting site. An improved version of the brick kiln for a higher capacity as built by for INBAR at Daboase may be adopted if production will be based on plantation production but labour to cut and carry wood to the burning site might increase production cost.

6.3 **Feasibility of charcoal in chainsaw communities**

It can be deduced from the study that it is feasible to promote charcoal production as an alternative to illegal chainsaw lumbering in chainsaw prevalent communities only if sustainable wood sources can be guaranteed. Hence, the woodlot planting program described above may be beneficial. Establishing *Cassia* in areas designated for firebreaks or boundary lines especially along the fringes of forest reserves bordering chainsaw communities are potential candidate areas for the proposed woodlot program. Labour concerns raised by the segment of chainsaw actors interviewed can be surmounted with the use of the brick or metal kiln which are less laborious and with shorter production period of 3-4 days. Beneficiaries then need to be supported with organizational and entrepreneurial skills and possibly loans at lower interest rates to enhance profitability of charcoal production.

7 FURTHER RESEARCH

This study has broadly covered the socio-economic aspects of the charcoal industry and its potential in chainsaw prevalent communities in Ghana. However, further research requires to be conducted to complete the aspects on investment implications of charcoal production in Chapter 4 as follows:

- Estimation of actual volume of wood, labour used, and corresponding charcoal output per unit kiln per production cycle. This will entail quantitative measurement of these production parameters on site for the earth mound, brick and metal kiln methods studied while production is in progress.
- A comparative analysis of incomes from illegal chainsaw and charcoal production

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APPENDICES

Appendix **1: Survey questionnaires**

EU-CHAINSAW PROJECT

COSTS AND BENEFITS OF CHARCOAL PRODUCTION IN GHANA

QUESTIONNAIRE FOR PRODUCERS

The purpose of this interview is to understand charcoal production trends to assist in developing workable strategies to ensure continued charcoal production from sustainable sources in Ghana.

A. GENERAL INFORMATION

1) Name of town ……..Name of market……

2) Gender……Education…… Origin……..

3) How many years have you been in charcoal production ……

4) Is charcoal the main economic activity you undertake (i) Yes (ii) No

1) If No, what is your main economic activity (i) Farming (ii)Trading (iii) Other

2) Who introduced you into charcoal production? ……

3) What production system do you practice? (i) Tradition Earth Mound (ii) Traditional Brick Kiln (iii) Metal Kiln

4) What is your source of wood for charcoal? (i) Own farm (ii) Forest (iii) fallow lands iv. Other…..

5) What are some of the trees you use for the charcoal
i…….. ii……. iii…….
iv……v……

6) Do you supply special types of charcoal to your customers? (i) Yes (ii) No

7) Who are your major consumers (i) Whole sellers (ii) Retailer (iii) Consumers (iv) Middle men

8) What characteristics of charcoal do you normally supply to customers
(i) Hard (ii) Soft (iii) Heavy (iv) Light
(v) Hard and light (vi) Hard and Heavy (vii) Soft and Heard
(viii) Soft and Heavy

9) Why those particular characteristics:……....

10) How often do you produce charcoal in a week……

11) How many bags of charcoal are you able produce per **production cycle**?
(i)..... Small size bag (ii)..... Large size bag

12) How many bags of charcoal are you able to **produce in a week**?
(i)..... Small size bag (ii)..... Large size bag

13) Are you always able to sell all the charcoal you produce? (i) Yes (ii) No

14) At which month do you normally produce more ……
……..…….....

15) Reasons for the rise in production around that month ……
…….....

16) Mention some problems you encounter in your charcoal production

……
…….....

17) Suggest ways to improve the production of charcoal in Ghana

……
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B. COSTS AND RETURNS FROM CHARCOAL PRODUCTION

a) Costs

I. Operational: recurrent expenses

Item	Quantity used per one production cycle (*No. of people x no. of days*)	Unit cost (GH¢)	Total value (GH¢)
i) Labour			
Labour for harvesting wood			
Labour for cutting wood into pieces			
Labour for **collecting wood** for one production cycle			
Labour for **packing wood**			
Labour for **firing and managing fire**			
Labour for **quenching fire**			
Labour for **raking out the charcoal** from the fire			
Labour for **packing into bags**			
Amount of water for quenching fire (drums, gallons, baskets, etc.…)			
Other operational costs			
Labour for on loading charcoal into vehicle			
ii) **Material and Marketing costs**			

Item	Qty used per production cycle	Price per unit (GH¢)	Total value (GH¢)
Wood			
Packaging (bags)			
Transport to market centre or point sale			
Labor cost for offloading vehicle			
Waybill at point of loading			
Levy at point of delivery			

II. Capital Items/Equipments

Item	**Age**	**Frequency of replacement**	**Quantity**	**Unit cost (GH¢)**	**Total value (GH¢)**
Kiln					
Axe					
Cutlass					
Rake					
Other					

b) Output

Quantity of charcoal produced per cycle	Cost per unit of sale(GH¢)	Total value (GH¢)

EU-CHAINSAW PROJECT

ECONOMICS OF CHARCOAL PRODUCTION FROM WOOD FUEL PLANTATION QUESTIONNAIRE FOR PLANTATION PRODUCERS

A. GENERAL INFORMATION

Age of plantation…….....

Expected rotation age to harvest …….....

B. WOODLOT ESTABLISHMENT AND MAINTENANCE

Year 1: Woodlot Establishment

With or without food crops ……

i) **Costs**

Production parameter	Quantity	Cost per unit	Total cost
Land (ha/acre)			
Labour			
Clearing/preparation			
Pegging			
Planting			
Replacement of dead seedlings (beating up)			
Wedding 1			
Weeding 2			
Weeding 3			
Harvesting maize			
Harvesting cassava			
Seedling			
Maize seeds			
Cassava sticks			
Other seeds			
Cutlass			
Hoe			
Pegs			
Maize bags			

Other inputs			

Output: Year 1

Crop	Quantity harvested	Unit of sale (Bags/ bunches/baskets etc.)	Cost per unit of sale (GH¢)	Total value (GH¢)
Maize				
Cassava				
Other crops				

Year 2: Maintenance

i) Costs

Production parameter	Qty	Cost per unit	Total cost
Weeding 1			
Weeding 2			
Harvesting crop			

ii) Output: Year 2

Crop	Quantity harvested	Unit of sale (Bags/bunches/ baskets etc.)	Cost per unit of sale (GH¢)	Total value (GH¢)
Maize				
Cassava				
Other crops				

Year 3: Maintenance

i) Costs

Production parameter	Qtty	Cost per unit (GH¢)	Total cost (GH¢)
Weeding 1			
Weeding 2			
Harvesting any food crop			

Output: Year 3

Crop	Quantity harvested	Unit of sale (Bags/bunches/ baskets etc.)	Cost per unit of sale (GH¢)	Total value (GH¢)
Maize				
Cassava				
Other crops				

Year 4: Maintenance

i) Costs

Production parameter	Qty	Cost per unit (GH¢)	Total cost (GH¢)
Weeding 1			
Weeding 2			
Harvesting wood			

Output: Year 4

Crop	Quantity harvested	Unit of sale (Bags/bunches/ baskets etc.)	Cost per unit of sale (GH¢)	Total value (GH¢)
Maize				
Cassava				
Other crops				

Year 5: Maintenance

i) Costs

Production parameter	Qty	Cost per unit (GH¢)	Total cost (GH¢)
Weeding 1			
Weeding 2			

Output: Year 5

Crop	Qtty harvested (bags/bunches/ baskets etc.)	Cost per unit of sale (GH¢)	Total value (GH¢)
Crop			
Wood	Qtty harvested (unit bundles, pieces, truck)	Cost per unit of sale (GH¢)	Total value (GH¢)

CHARCOAL PROCESSING AND SALE

1. Capital Items

Item	Age	Qtty	Unit cost (GH¢)	Total value (GH¢)
Kiln				
Axe				
Cutlass				
Rake				
Others……..				

Operational: recurrent expenses

Item	Age	Qtty	Unit cost (GH¢)	Total value (GH¢)
Labour				
Overheads				
Electricity				
Consumables				

Charcoal output

Item	Qtty produced per period/area of estimated cost	Price per unit	Per Unit (GH¢)	Total value (GH¢)
Charcoal				

Marketing and distribution

Clients:

Point of sale:

Costs:

Item	Qtty	Cost per unit (GH¢)	Total value (GH¢)
Packaging (bags)			
Transport to market centre or point sale			
Waybill at point of loading			
Levy at point of delivery			

Appendix **2: Checklist for assessing the feasibility of charcoal production in chainsaw communities**

1. What alternative forest based livelihoods exist
2. How will charcoal production compete or compliment these activities
3. Assess raw material availability for charcoal
4. Assess tenure –access to resource (trees and land)-institutional arrangements for access and use
5. Potential for charcoal forests/woodlot development (land availability, etc.)
6. Capital requirements and availability for the charcoal enterprise
7. Willingness and interests of chainsaw people to go into charcoal production
8. What aspects of the chain are people willing to participate in (raw material production, processing, marketing, etc.)
9. Existing charcoal marketing strategies
10. Employment and revenue generation potential of charcoal
11. Potential environmental and socio-economic impacts
12. Potential barriers or challenges and possible alleviation measures
13. Implications for promotion of charcoal production at the project sites (what resources will be required, raw material, tenure issues, how can the people and production, distribution and marketing process be managed, etc)

This report was produced within the framework of the EU Chainsaw Milling Project "Supporting the integration of legal and legitimate domestic timber markets into Voluntary Partnership Agreements". The project aims to find sustainable solutions to the problems associated with the production of lumber for local timber markets by involving all stakeholders in dialogue, information gathering and the development of alternatives to unsustainable chainsaw milling practices. In Ghana, the project is being carried out by Tropenbos International (TBI) in collaboration with the Forestry Research Institute of Ghana (FORIG) and the Forestry Commission (FC).