

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEDGE OF AGRICULTURE AND RENEWABLE NATURAL RESOURCES**

**SOCIO-ECONOMIC ANALYSIS OF WOOD FUEL PRODUCTION AND
UTILIZATION- CASE STUDY OF THE UPPER DENKYIRA DISTRICT**

**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, KWAME
NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI IN
PARTIAL FULLFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
MASTER OF SCIENCE IN AGROFORESTRY**



BY

LAWRENCE AMOH-ANGUH

BA, GEOGRAHPY& RESOURCES DEVELOPMENT WITH SOCIOLOGY

JUNE, 1998

CERTIFICATION

Certified that, this thesis is the candidates own account of his research, and all citations have been duly referenced and acknowledged

.....
Lawrence Amoh-Anguh
(Student)



.....
Dr. Joe J. Afuakwa
(Supervisor)

DEDICATION

This research is dedicated to my son Emmanuel Amoh-Anguh to inspire him to greater heights of achievement.

KNUST



ACKNOWLEDGEMENT

This research was initially carried out in the College of Agriculture and Natural Resources, Kwame Nkrumah University of Science Technology (KNUST) under the supervision of the late Dr. Charles Adu-Anning.

I am very grateful to the late Dr. Charles Adu-Anning who took the pain to assist me from the very onset of the research. His forbearance and unsparing supervision is very much appreciated.

I appreciate the efforts of Dr. Joe J Afuakwa, my supervisor for his assistance in getting this research project completed.

I would also acknowledge Dr. Paul Sarfo for his immeasurable support during the development of the synopsis of the thesis. A lot has been drawn from his knowledge and experience on socio-economic background in Agriculture-land use systems.

I would also want to acknowledge the assistance offered by Dr. K .O. Agyemang in the Department of Planning during the initial stages of the project.

Mention must also be made of the staff of the Department of Forestry, Upper Denkyira District for the technical support offered me during the field survey.

Finally, I am very grateful to Musbee Business Centre at Ayeduase near KNUST, which did most of the type setting of this project.

ABSTRACT

This thesis looks at the socio-economic analysis of wood fuel (charcoal & fire wood) production and utilization in the Upper Denkyira District in the Central Region. The main objective of the study was to determine the contribution of the wood fuel industry to sustainable livelihood in the study area. The study was premised on the central theme that producers of wood fuel do not produce their own wood lot aimed at producing their own wood for fuel.

The study mainly draws its materials from the survey undertaken in the study area. In the study, 33 producers and 115 users of wood fuel were sampled from five (5) communities in the district. Distributors/ marketers and woodlot practitioners were also selected for the survey.

A combination of structured questionnaire, focal group discussion (FGD), personal observations and wood fuel measurements were employed as data collection methods. Data was analyzed quantitatively and qualitatively to arrive at the results and findings.

The major findings of the study were that the raw materials for the processing and production of wood fuel found in almost all the five (5) communities selected for the study came from the natural forest: people did not plant their own wood (trees) to use them as fuel for both domestic and/or commercial purposes. The study identified that processors and producers of wood fuel faced tenure problems, forest laws (in some cases) and other economic constraints. This situation occasionally resulted in the demand for the product exceeding supply resulting in price increases. Proper measures should be put in place to

ensure efficient and sustainable production of the product if any future shortages were to be avoided. This finding has substantiated the hypothesis of the study that producers of wood fuel do not produce their own wood lot. In some instances, alternative means of providing wood for wood fuel (woodlot production) were found to be on going among some individuals in the selected communities but whose main motive was for timber and pole production. Some educational institutions had woodlot that occasionally fell some for wood fuel. The research found that most of the wood fuel actors have indigenous ideas about Agro-forestry, and could be a starting point for the introduction of the scientific wood planting. Most of the preferred tree species were in scarce supply due to their gradual extinction through identified factors such as farming, mining, logging and wood fuel sourcing.

The quantity and the cost of production of wood fuel depended on factors such as availability of wood (trees), land and tree tenure system in the area, the effectiveness of forestry laws and the location of the producing area with regard to the area of demand (i.e., transportation cost). Labor cost was not a critical factor in determining the cost of wood fuel production in the study area because of the existence of reliance on family hands by most of the producers. Charcoal was produced by the earth mound method more than the other modern methods like the kiln.

The study again identified that women and children were the dominant labor force for the production of wood fuel, with male counterparts performing a smaller proportion of felling of trees. Species of trees preferred for wood fuel included, *Khaya spp*

(mahogany), *Milicia excelsa* (Odoum), *Seltis spp* (Esa), *Cylicodiscus gabonensis* (Denya) and *Piptadeniastrum africanum* (Dahoma).

The distribution/ marketing of the product were done with various modes. Most domestic users gathered and conveyed it by head loading. Commercially, truck and other vehicles were used as a popular mode. Commercial production needs permits from district Forestry Department and this attracted a fee per tree in a defined concession.

The research found that some supply of wood fuel came from a neighboring district other than the Upper Denkyira District. Majority of the products are sent to the capital town, Dunkwa where the demand and prices are very high. Occasionally, wood fuel is also supplied to a neighboring town like Obuasi.

Consumption of wood fuel in the study area is very high as compared with other sources of energy. The demand for firewood for domestic cooking and heating was very high in all the five (5) communities the survey took place. The preference for firewood begins to give way to charcoal and liquefied petroleum gas (LPG) as the geographical size and the income levels of the residents' increase. Commercial use of wood fuel included, bakery, local gin distillery and food vendors.

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CHAPTER ONE

INTRODUCTION

1.1 Background and justification of the study

Wood fuel is a widely used energy source of the world. More than 50% of the world's annual wood production is utilized as fuel and of this 90% is used in the developing countries (FAO, 1971).

The majority of the population in the continent of Africa depends on wood fuel as source of energy. In the sub-Saharan Africa (excluding S. Africa), this source constitutes 75% of total energy consumption (Ardayfio-Schandorf, 1993; Karekezi, 1993; Openshaw, 1990). The use of wood fuel ranges from as low as 43% and 46% of total energy consumption in countries such as Zimbabwe and Mauritius to as high as 86%, 94%, 95% and 97% in Kenya, Mozambique, Sudan and Rwanda respectively (Hall and Rosillo-Calle, (1993). In Ghana, the consumption rate is put at 75% of all energy need (Nketia et, al; 1988).

There is a mounting interest in the wood fuel sector, and a lot of studies have gone on regarding how best wood fuel could be used as an alternative means of meeting the ever increasing energy need of the world's population. According to Osei, (1988), wood energy studies have become indispensable for the following reasons:

1. The majority of the world's population, especially those living in the rural areas and the informal sector of economy are wholly fuelled by wood and that within the short to the medium term such condition is likely to persist.

2. It is relatively cheaper to maintain the wood production as compared with the high cost of fuel import if a positive policy to master the necessary local and scientific technology can be put in place.

Wood fuel is not only used in poor and rural households, but in many towns and metropolitan areas, wood fuel is widely used either as main, substitute or supplementary fuel by all manner of people irrespective of the level of income earned. The major reasons attributed to wood fuel usage are its affordability, gathered/collected free in some cases and the higher taste and preference of consumers for it. It is also used as a backup fuel. In the commercial and industrial sector, large number of (prepared) –food vendors, such as restaurants and bakeries use wood fuel; distillery factories and blacksmiths also depend on wood fuel. Institutions such hospitals, schools and prisons are among the highest consumers of wood fuel in many developing countries (Bensel and Remedio, 1993).

Contrary to the common belief, not all wood fuel is sourced from natural forest. Wood fuel production takes place within several types of land use, such as tree/shrub fallow, wood lots, tree plantation sites, reforestation and agro forestry systems (Lungreen, 1982, Agro forestry in Ghana, 2002). Trees from these sources are harvested, where they can be split, bundled, according to size of fire wood or converted to charcoal.

The system of wood fuel trade in a country varies and is often dependant on factors such as the location and distance of fuel wood production site, manufacturers, rural and urban traders, the type of fuel being traded and the regulatory policies of fuel in place. Despite

the social and economic importance of fuel wood production and utilization, relatively little is known about how wood fuel is produced, managed, traded and consumed in many countries.

There is generally insufficient and unreliable data on wood fuel (Donovan, 1981). This has among others contributed to wood fuel not being used in a sustainable way, culminating in wood fuel crisis and other environmental problems such as reduced biodiversity and deforestation in some parts of the world. Reliable and accurate information is needed to make the wood fuel industry a viable one. Many countries have not commoditized/ monetized wood fuel trade and therefore making it difficult to measure its true socio-economic benefits. Again, lot of wood fuel is used without any official notice compounding the problem of economic evaluation thereof (Earl, 1975).

In many South and Southeast Asian economies, some 20 to 80% of the energy demand is met by wood. These countries have been able to scientifically study and develop the wood fuel sector, which has consequently opened a lot of opportunities to them. In the Philippines for example, firewood, charcoal and other form of biomass energy make a major contribution to meeting the energy requirement of the population. The collection, distribution and trade of these fuels also provide income and employment to millions of Filipinos.

Ghana, though one of the countries whose economy is heavily dependant on wood energy, lacks proper production techniques of fuel wood. This has not made the country

able to unearth the potential of her rich forest resources in wood energy. A better understanding of the linkages between wood fuel and development of a country can go a long way to improve a country's use of this vital energy source.

The concept of *socio-economic analysis* as used in this study among others, looks at how the key players of wood fuel are influenced by the wood fuel industry in the study area, how the impact differs among groups (household, institutions etc), demand and supply situation of wood fuel, some of the significant social and economic contributions (such as to employment, income) that wood energy production and utilization have made to the inhabitants and the livelihood of the stake holders of wood fuel in the Upper Denkyira District.

1.2 Statement of the Problem

The study area, as is common in other part of the country, cannot boast of any sustainable production of wood fuel. Greater proportion of study area's population lives in the rural communities and depends heavily on wood fuel as the main source of energy (3-year Medium Term Plan 2002). Sizeable portion of the inhabitants depend on the natural forest for wood fuel need thereby exerting significant toll/pressure on the forest resources. The on- going establishment of cassava flour/ starch processing factory in the district will increase the demand and supply of wood fuel since the factory is to be fueled by wood energy.

The wood fuel industry (production, trade, consumption) is not well structured and hence difficult to propose any interventions based on Agro forestry technology or planning. The District since its inception has lacked statistics on wood fuel. This does not permit proper planning/policy formulation, regarding the production, distribution and utilization of wood fuel in order to make the wood fuel business economically feasible, socially desirable and ecologically viable.

This study of the socio-economic analysis of wood fuel production and utilization is therefore very important to the District. It will serve as baseline information upon which scientific assessment of wood fuel may be made for the study.

1.3 Objectives of Study

The general objective of the study was to determine the contribution of the wood fuel industry to sustainable livelihood in the study area.

The specific objectives were:

1. To determine the production and utilization patterns of fuel wood
2. To identify the marketing and distribution channels of wood fuel
3. To measure the volume of wood fuel consumed by households
4. To examine the institutional arrangements, structures and processes affecting the products, processing and marketing of wood fuel.

1.4 Hypothesis of the Study

The hypothesis of the study was that, producers of wood fuel in the study district do not establish wood lots to produce wood fuel to ensure sustainable supply. Producers rather

depend on the natural forest for wood fuel and therefore contribute to deforestation and eventual wood fuel shortage.

1.5 Scope of the Study

The study was undertaken in five (5) communities (Oponso/ Esikuma, Diaso, Ayamfuri, and Kyekyewere) where wood fuel (firewood and charcoal) is produced in large quantities for the entire district and the capital Dunkwa -on- Offin is where greater portions of the product is supplied to and consumed. The study also researched into and traced the areas where the wood fuel is supplied to in the district, and beyond.

The study identified and assessed the significant socio-economic benefits and cost associated with the production and use of wood energy to evaluate its impacts on the livelihood of the people of the district. Among the socio-economic indicators/parameters that the study touched on included: employment, income, tree tenure, wood lot production and policy arrangements that are in place. Wood fuel cycle (production, trade and consumption) and linkages with the stated parameters was drawn. Ecological/ environmental impact assessment of wood fuel production and utilization did not form part of the scope of the study.

1.6 Organization of the Study

This study is divided into five chapters. Chapter one is an introduction to the study. Chapter two gives the relevant literature on the social-economic issues of wood fuel production and utilization and a background to the study area. Chapter three describes the studies methodology and the general organization of the study. The analysis of the survey data is presented in chapter four. Chapter five is devoted to summary and conclusion.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

There is the tendency in many countries to give more prominence to environmental issues in development than the socio-economic issues thereof. For some time now social issues of development activities have been relegated to the background in the analysis and policies of countries (Ghai, 1992). Thus the impact of development, transfer and adoption of agricultural or forestry and most land-use activities have been based on the biophysical environment of the targeted group. This has strengthened studies and research on environmental related factors such as land, soil and trees (Ghai, 1992).

There is however an emerging school of thought that places emphasis on the socio-economic aspect of human development and land-use practices. It has been realized that the high rate of policy failures could be attributed to the poor consideration given to this dimension of development among countries and policy makers. It is widely acknowledged that the socio-economic issues and factors have a role to play in households/farmer's decision to adopt a new innovation and to keep practicing it (Caveness and Kurtz, 1993; Ghai, 1992).

It is to add to this emerging school of thought that this literature seeks to contribute. It is also to fit this study in the context of the numerous studies that have been done on the socio-economic of wood fuel production and utilization.

The literature in this study has been organized in two parts. The first part touches on some selected topics on social and economic issues bordering on wood fuel and the second part a background review of the geo-physical and the socio-economic characteristics of the study area.

2.1 Quantitative Assessments of Wood fuel Production and Consumption

2.1.1 World Production and Consumption

Wood fuel is a widely used energy source of the world. Current estimates indicate that biomass energy is the fourth most important source of energy of the world (Hall, 1990). Biomass energy still accounts for a substantial of the world's energy supply, contributing higher than the modern nuclear and hydroelectric energy. In the developing countries, the proportion is even more, ranging from 80% to 98% of all energy consumed.

The importance of wood as primary sources of energy varies widely among different part of the world. For example, the FAO reported in 1971 that more than 50% of the world's annual wood production was used as fuel and of this more than 90% was used in the developing countries. Coder (1973) observed that the more industrialized nations used less wood fuel and the less industrialized used more wood fuel. For example, Africa and Latin America where industrialization is low, 90% of all wood used is for fuel and in Asia, 65%, but in Europe it is 25% and 10% in N-America (Earl, 1972).

The table below contains the report of FAO on the annual wood fuel production and consumption of the world in cubic meters.

Table 2.1 World Annual Wood Fuel Productions and Utilization

Years	Production (000) m³	Consumption (000) m³
1993	1,889,721	1,790,048
1994	1,911,186	1,810,532
1995	1,932,315	1,831,745
1996	1,947,092	1,846,198
1997	1,954,481	1,853,313

Source (FAO, 1998)

The rate of increase in both consumption and the use of wood fuel have been averaging around 1% per annum. The most recently available figures for wood fuel consumption indicates that demand will decrease in developed countries and increase in developing countries given an overall rise in the total amount expected to be used Earl, (1972). He noted that most of the non-forest energy is used by the developed world. Developing countries use more forest energy as an essential part of their economies than developed countries but the value of this is often non-tradable, not used in the calculation of the Gross National Product (GNP), which consequently undervalues the real standard of economic growth reached by developing countries.

According to an FAO report, (1975) wood fuel for centuries has remained an affordable and reliable source of domestic energy for the rural population of developing and the less industrialized countries. The tendency in developing countries is to increase the

percentage of wood converted to charcoal as urbanization increases the comparative advantage of charcoal over firewood for domestic use (FAO, 1990).

2.1.2 Production and Utilization of Wood Fuel in Africa

The production and utilization of wood fuel in Africa have been on the increase, averaging a little over 1% per annum.

The Food and Agriculture Organization (FAO) yearbook on forest product gives the production and consumption figures as seen in table below:

Table2.2 Annual Wood Fuel Production and Utilization in Africa

Year	Production (000) cub. m	Consumption (000) cub. m
1993	475,182	475,167
1994	490,578	490,450
1995	502,548	502,437
1996	514,051	513,773

Sources: (FAO, 1998)

The most important sources of biomass fuel in Africa are wood fuel (fire wood & charcoal), crop residue and animal dung. In the Sub-Saharan African (excluding S. Africa), this source of energy constitutes 75% of total energy consumption (Ardayfio-Schandorf, 1993; Davidson and Karekezi, 1993; Openshaw, 1990). The use of it ranges from as low as 43% and 46% of total energy consumption in countries such as Zimbabwe and Mauritius to as high as 86%, 94% and 97% in Kenya, Mozambique, Sudan and Rwanda respectively (Hall and Rosillo-Calle, 1993).

Though biomass is widely consumed in the rural areas of Sub-Saharan Africa, it provides energy for urban poor as well as small-scale industries and public institutions (Rosillo-Calle and Hall, 1992). In Ghana for example, wood fuel is used in both rural and urban centers for most domestic purposes such as cooking, space heating, and some industrial activities such as bricks and tiles manufacturing, pito (local beer) brewing, pottery production, oil extraction from seed and fish smoking.

The Food and Agriculture Organization (FAO, 1997) undertook a survey in order to determine wood fuel supplies and demands for developing countries in Africa (1980-2000 period of survey). The result of the survey painted the picture of wood fuel production status in Africa and was able to delimit the following.

- Areas where there has been over-exploitation of biomass to the extent that there is fuel shortage.
- Areas where wood fuel demand is in excess of sustainable supply, referred to as crisis region.
- Areas where population growth is likely to give rise to crisis in the foreseeable future as satisfactory.

The survey graded the Sudano-Sahelian region, especially those in the Sahelian as having reached the critical point. Acute shortages are to be expected especially in the rapidly growing peri-urban areas. The increasing scarcity of wood fuel is a subject of major concern in Africa and the rest of the developing world. Kgathi (1993) explained that the current wood fuel situation is caused by rapid increase in human population as well as by market and policy failures. He referred to market failure as the failure to price a resource

at full social cost of production. The policy failure is the failure to intervene when it is necessary and beneficial to do so (Openshaw, 1989). Population growth is a 'driving force' behind the process of deforestation, which is linked directly with the wood fuel problem because it leads to increase in agricultural land clearing and wood fuel demand. On the other hand, market and policy failures are 'accelerating forces' mainly because of a lack of property right in the open access regime of most developing countries, which encourages over-exploitation of woodland resources. Earl (1972) said that Africa countries see wood (forest) as an abundant social good and it is through only the institution of suitably planned economic growth based on the realization of the importance of this indigenous renewable fuel resource that wood (forest) could be saved from degradation.

2.1.3 Production and Utilization of Wood fuel in Ghana

Ghana like most of the developing countries depends heavily on wood fuel as a source of energy. The total annual national charcoal and fire wood consumption rose from 8.2million tonnes in 1985 to 9.96 million tonnes in 1990. This got to 11.7 million tones in 1994. Based on national population growth figures, it is now clear that charcoal and firewood consumption rates are respectively growing at 5% and 3%. If this growth trend should continue, Ghana is likely experience wood fuel shortage by 30 years time (Gbeogo Rural Energy Planning Committee, 1994). The table below indicates the growth in wood fuel consumption over the years.

Table 2.3 Annual Wood Fuel Consumption in Ghana

Years	Total wood fuel consumption (million tonnes)
1985	8.2
1986	8.5
1987	8.9
1988	9.2
1989	9.6
1990	10.0
1991	10.4
1992	10.8
1993	11.2
1994	11.7

Source: A paper presented at a Workshop for Gbeogo Rural Energy Planning Committee on Cultivation and Efficient utilization of fuel wood resources in the Upper East Region, 28-30th June 1994.

2.2 Household consumption of wood fuel in Ghana

In all, 69.1% of households use firewood as the main source of wood fuel for cooking and other domestic purposes. This is followed by charcoal with 26% and to a lesser extent 3.2% use gas or electricity (Ghana Statistical Services, 1999).

2.2.1 Urban Consumption of Wood Fuel

Increase in reliance on modern fossil fuels and electricity rather than wood fuels usually accompanies economic development. As national income rises, more people are able to increase cleanliness, convenience and efficiency associated with modern fuels. For example, wood fuel typically makes up 60-95% of total energy use in poor developing countries, 25-60% in middle income countries and less than 5% in high income countries (Leach and Mearns, 1988).

The concept of energy transition is central to any understanding of urban fuel wood use. As urbanization proceeds there is a tendency for household energy use to increase in diversity and switch fuel from wood and charcoal to modern fuels. ESMAP (1990a) has discovered this pattern in Indonesia and discussed a number of examples showing a hierarchy of fuel preference with wood at the bottom. Firewood as a sole fuel is used by only 14% of urban households in Ghana (Nketia et al, 1988). It has been realized that un-affordability of expensive cooking gadgets by low income household compel them to depend solely on firewood which is economically feasible where locally designed furnace and stoves are available.

According to the Ghana Statistical Service Quarterly Report (1990), the use of firewood decreases in urban households as people become richer. The use of charcoal thus increases with decreasing poverty. It is estimated that in urban Ghana charcoal is consumed by an estimated 61.8 % (Ghana Statistical Service Quarterly Report, 1999).

2.2.2 Rural Consumption of Wood Fuel in Ghana

Wood fuel remains the dominant sources of energy to most rural settlers in Ghana. It is estimated that the majority of rural household, averaging 91% use some form of biomass especially fire wood and or charcoal as their main source of fuel (Ghana Statistical Service Quarterly Report, 1999).

Over the past decade there has not been any significant change in the status of wood fuel in the rural communities of the country. Many reasons have accounted for this, among these are:

1. Wood is found to be a renewable natural resource that is abundant in the forest, there is open access to it and lacks property right in many developing countries.
2. Wood is accessible physically, economically, and socially to most rural communities in developing countries.
3. Most rural areas in developing countries do not have access to gas and electricity for cooking and heating.
4. Kerosene provides a substitute only for the wealthy minority. As a result wood fuel plays a major role in supplying energy to the rural masses and the poorest group in the towns.

2.3 Types of and Techniques in Wood Fuel Production in Ghana

Various techniques are involved in the production of wood fuel in Ghana. While fire wood production may not need any special techniques, and or skills; charcoal production requires some amount of techniques and skills.

2.3.1 Fire Wood

Until recently, firewood was produced by a very simple method, sometimes without the use of tools such as the cutlass and axe. At the rudimentary level, mainly women and children are those who collect firewood from farmlands, community forest, forest reserves etc. Often dead branches, twigs, trunks of trees are pulled down by the use of simple tools, piled and bundled for conveyance to the home and/or for sale.

The recent development in the fire wood collection is where live and preferred tree species are intentionally felled and left to season (Tata, 1999). The increase in the commercialization of firewood has led to the emergence of firewood merchants, who sponsor firewood production by making available tree felling devices such as the chain saw, trucks to firewood producers to facilitate production of firewood.

2.3.2 Charcoal

The production of charcoal involves various processes and techniques. The common principle that underlies them all is the carbonation of wood. The process of converting wood into charcoal is termed as carbonization. Earl (1972) mentioned and described the various carbonation methods and the processes that are employed in the production of charcoal. Among the carbonation methods are: Kilns, Retort, Continuous kilns, furnaces. The modern carbonization methods evolved from a rudimentary earth- covered kiln and pits (earth mound) which was the earliest means of making charcoal.

2.4 Charcoal Production by Earth Mound

Nketiah et al (1987) identified the following as the stages involved in the production of charcoal in most communities in Ghana.

- a) Wood cutting
- b) Wood stacking and covering
- c) Wood carbonation
- d) Charcoal harvesting and bagging.

a. Wood cutting

Wood used for charcoal production is generally obtained by felling trees on fallow and farmlands. In areas where sawmills are operational, saw residues are sometimes used for charcoal production. With respect to tree felling, trees are often crosscut into billets of 1.0-1.5 m lengths. Where sawmill residues are used, the wood is mostly in slabs and edgings and the sizes are often smaller. Dry wood often produces greater yield charcoal than wet wood and time for carbonization is shorter. Moisture can be removed by air-seasoning wood before carbonization.

b. Wood stacking and covering

Pieces of dry wood are often laid on the ground first for easy ignition of the mound and the large pieces are then stacked on these pieces. The covering of the wood stack with grass is for the clogging of spaces in the wood stack in order to allow free air draught in the mound especially during the carbonization stage. The stack is completely covered with loose earth. In sawmills, the stack may be covered with sawdust.

c. Wood carbonization

Carbonization is the process of combusting part of wood until it is hot enough to be able to react exothermically in a limited air supply. The method of carbonization is to upgrade the value of wood as fuel energy. Charcoal is produced as a result of the chemical reduction of organic material under controlled condition.

During the stacking and covering of the wood, hole and air inlets are created where fire is inserted. Dry twigs are burnt in this hole to initiate carbonization. Complete carbonization takes about 10 days depending on the size of mound and the moisture content of wood.

d. Charcoal harvesting

At the end of carbonization, the producer harvests the charcoal by first removing the loose earth and the grass. Often water is used to put off/cool down the hot and sometimes still burning charcoal. When the fire in the charcoal is put off, it is allowed to cool down, it is then filled into a jute sacks, ready for conveyance.

2.5 Characteristics of Good Wood Fuel

The physical and chemical properties of charcoal depend partly on the original materials from which it is made and partly on the condition of the carbonization process.

Most charcoal users prefer the hard and uneasily breakable ones, which can be ignited readily and will continue to emit heat for a long time. Traders who mix different charcoal (hard & soft) together obtain charcoal of acceptable quality. This gives them the 'proprietary blend'.

The following summarizes the general features of wood charcoal.

Yield by weight20-30% of the dry weight of wood

Yield by volume.....50% of volume of wood

Percentage yield of lump charcoal... 75-90%

Hardness.....varies according to the density of wood

Moisture1-16%

Volatile matter (mainly hydrocarbons)...7-30%

Fixed carbon80-90%

Sulphur.....trace

Ash.....0.5-10%

Source: Earl, 1975.

2.6 Trade and Marketing of Wood Fuel

Every producer aims at getting his produce to the final consumer. To be able to achieve this, entrepreneurs study the distribution channels of their commodities from the point of production to that of consumption. Where, middlemen are involved in the distribution processes, their role and links with the producers and the consumers should be defined.

In his study, Tatta, (1999) identified channel of distribution of wood fuel in Cameroon.

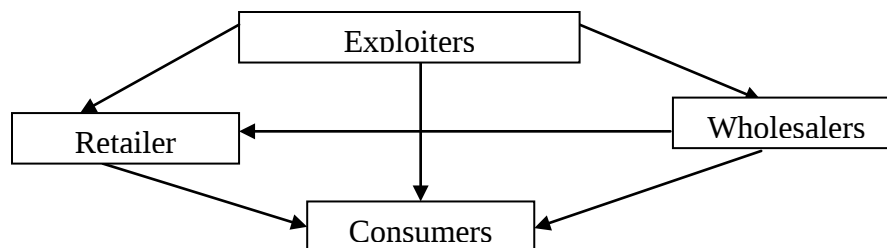


Fig. 2.1 Relationship among various actors in the wood fuel industry

Source: Tatta, (1999)

The chain of distribution of wood fuel as depicted in the figure above may be applicable in other countries. According to the chain, producers of wood fuel may sell their products direct to consumers or pass them to first wholesalers and then to retailers before consumers get them. A situation may also arise where producers can have only one middleman (retailers or wholesalers) coming in-between them and the consumers

2.6.1 Wholesalers

According to Nketiah et al, (1987), in Ghana most of the wholesalers are elite who may be men or women. Their main duty is to contract with wood fuel producers to purchase the product in bulk. They may have their own truck and supply their own sacks to the producers. These merchants sometimes pre-finance the production of the wood fuel and negotiate with local authorities that are custodians of the land and trees to have access to wood from the forest. Some provide inputs such as chainsaws and axes. The merchants distribute their products to retailers in the urban towns.

2.6.2 Retailers

This group of the chain of distribution is much bigger than the wholesalers. They are mostly poor peasant women who receive few bags of charcoal and bunch of firewood at a time and sell them in small measure. The study, which was conducted in the major towns of the country, reported that public and civil servants, housewives and self employed people are also involved in retailing of wood fuel. The retailers break the bags of charcoal and the bundle of firewood into smaller measures and sell in basins, tins and heaps.

2.6.3 Consumers

The major consumer of charcoal and firewood is the household. According to the Ghana Statistical Service, 1999, an estimated 69.1% and 26% of Ghanaian households used firewood and charcoal respectively. Very little is used by institutions and informal sectors in commercial activities. From the records of the Export Promotion Council, a meager of 210 tonnes of charcoal was exported to the United Kingdom between January 1987 and March 1988. Earl, (1972) said that it seldom pays to export firewood because of the low value-bulk ratio.

2.7 Consumption Pattern of Wood Fuel

The consumption of wood fuel has been following a particular trend in most economies. In the developing world, wood fuel dominates all domestic sources of energy. It has also been realized that wood fuel is used in greater proportion by rural than urban households. The growth and expansion of the city obviously had implication on the socio-economic life of the people and natural resource management for the development of the city and fringe communities or its peri-urban interface. As income of individuals rises people are able to afford the expenditure of modern fuel (Leach, 1988 and Mearns 1988). It has been estimated that in Ghana 91.8% of rural households use wood fuel as the main source of energy (Ghana Statistical Quarterly Review, 1999).

As urbanization proceeds there is the tendency for households energy use to increase in diversity and switch fuel from wood and charcoal to modern fuel. In a study by Nketiah et al; (1987), the following revelation came to light regarding the preference for different energy sources in Ghana's urbanized areas:

- Charcoal- 29.8%
- Firewood-11.7%
- Kerosene -23.5%
- Gas-17.7%
- Electricity-17.1%

This data from the research indicates that people vary their mode of energy use; people show preference for other modern energy as access to them become available.

Seasonally, wood fuel consumption has taken a particular pattern. AFREPRAN reported that the average household consumption of wood fuel is higher in the dry seasons than in the wet seasons. Reasons given in support of this is that, in the dry season, space heating is greater and that wood fuel burns faster because the weather contributes to greater rate of burning. Report on this trend of wood fuel consumption in Ghana is not well researched into.

2.8 Production Pattern of Wood Fuel

The production and procurement of wood fuel follow a pattern. In countries where research of this nature has taken place, it is realized that the collection of and decision on wood fuel especially is done by particular sex and age. (Kgathi et al; 1994) revealed that the allocation of labor on wood fuel collection is based on the magnitude of the opportunity cost of household labor such that members of the household with low opportunity cost such as children and women tend to be allocated the task of wood fuel collection. In Kenya, wood fuel procurement is the specific task and responsibility of

women (Chanangi et al; 1991). A similar study in Nigeria by Ardayfio-Schandorf (1981) indicated that women living in a highly deforested area have burden of spending more time collecting and carrying firewood.

This principle of fire wood procurement by those with lower opportunity cost of labor may not be applicable in most part of the rural communities where both sexes of whatever age is competing with the other for any opportunity. Although the cultural expectation in most Africa countries and for that matter Ghana is that the women should make decision on wood fuel, this could be defied in some cultural settings in a modern settlement especially when fuel is scarce.

In a situation where wood fuel production has become an income-generating venture, wood fuel procurement is not left to only women and children.

2.9 Institutional Arrangements and Policies affecting Wood Fuel Production

The use of natural resources to satisfy human wants must be guided with caution since any wanton exploitation of it could lead to environmental degradation, which may not be reversible. The exploitation of forest trees for biomass can have a negative toll on the environment. In an attempt to guard against this indiscriminate practice and produce wood fuel in sustainable fashion, countries have put in place environmentally sound measures to protect biodiversity loss. In Botswana for example, the government has integrated conservation and sustainable use of biodiversity in all development planning (Holmberg et al; 1998). Similar programs are being pursued by other developing

countries in line with the spirit of the recent 'Earth Summit', which has as its objectives among others to provide for countries to develop national strategies for the conservation and sustainable use of their biological diversity.

Ghana was the 12th of the 157 countries that signed the convention in June 1992 (Government of Ghana, Ministry of Environment and Science, 2002). Ghana's socio-economic development and growth in the past had been achieved almost exclusively at the expense of the physical and non-physical environment. As far as depletion of wood resources is concerned, a number of policies have been suggested:

- 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.
- Introduction of modern charcoal production techniques.

Ghana needs more stringent measures to produce wood fuel in a more sustainable manner.

2.10 Woodlot Production and Management

The practice of establishment of woodlot and tree plantations is a recent phenomenon. Woodlot is an agro forestry technology where perennial trees to be principally served as wood fuel is managed. It can be managed over time with crops and animals. Community

forestry is established to provide wood and other forest products to local people. On a cultivable land the recommended spacing is 2 m x 2 m, 2 m x 3 m, or 3 m x 3 m. This enables inter-cropping to be practiced in the first few years before the canopy closes. On marginal lands, the recommended spacing is 1m x 1m. This ensures early canopy closure (Quashie-Sam et al; 1993).

In Ghana, more emphasis is being given to the role of forestry in promoting rural development. Some individuals, groups and institutions have begun some form of woodlot plantation (Nketiah et al, 1988). A national tree plantation program was launched in 1983 to create a countrywide awareness of the danger of deforestation. The Forestry Department provided the lead role. The strategy was to carry the fight to the 89% of land outside the forest reserve by getting local communities to participate in reforestation. The objectives of this program were basically to:

- Improve nutrition through food and fodder
- Creation of shelterbelts
- Meeting energy needs
- Protecting the environment (soil & water).

During the 1996 year, Ghana was able to establish about 49,000 hectare of forest plantation to serve as stock for fuel and pole.

Reporting on some of the advantages of woodlot development, Longan (1965) said that the homogenous nature of crops and the fast rate of growth achievable by fast growing plantation trees provide very high out-turn of harvestable wood per hectares. In

consequence, substantially smaller area of land is used for wood production. This may be of great advantage in countries, which have limited access to land for food production or settlement. It also reduces the cost of production and supervision. In harvesting the high out-turn per hectare and uniform nature of crops makes for lower cost of per unit of wood extraction. Longman again noted that under favorable conditions, quick growing plantation could be a very profitable financial undertaking especially in developing countries where labor cost is low and land available.

2.11 Socio-economic Importance of Wood Fuel

Varying conditions and lack of data makes it difficult to apply standard methods for the appraisal of the importance of wood fuel especially when more complex theories are applied such as induced and multiplier effects. In countries where wood fuel production is well organized, a lot of direct opportunities are generated through the processes involved in woodlot plantation, in the construction, operation and maintenance of conversion plants and in the transport of wood fuel; and indirect opportunities generated within the economy as a result of expenditures related to wood fuel cycle (Faaij, 1997).

Some of the socio- economic benefits derived from wood fuel production enumerated by Earl (1974) includes:

- Creation of employment
- Provision of money for the rural sector
- Savings in foreign exchange
- Provision of chemical fuel for chemical industry
- Increasing the total profitability of the forest

- Provision of smoke less fuel for cities (charcoal)

2.11.1 Creation of Employment

The wood fuel sector employs many men, women and children in both rural and urban areas, offering both temporal and permanent employment opportunities. It is important economically because it offers immediate sources of employment to those found in the chain of distribution (exploiters, wholesalers, retailers).

Formal-sector employment opportunities include direct employments comprising jobs involved in tree plantation, in the carbonization processes, transportation of wood fuel from the point of production to the prospective consumers and other indirect job opportunities generated as a result of expenditures related to the wood fuel cycle (Faaij, 1997). The production of biomass demands larger labor force than most of the other forms of energy. Human labour required for the production of biomass resources is about five times higher than that needed for the production of fossil fuel. For example an analysis from Brazil has shown that charcoal production contributes to national employment with some 200 000 to 300 000 jobs.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Background of the study area

3.1.1 Site Location

The Upper Denkyira District lies roughly within latitudes 5° 30' and 6° 02' north of the equator and longitude 1° W and 2° W of the Greenwich Meridian. It shares common boundaries with Adansi West District and Amansie East District to the North. Assin North District is located in the East, Twifu Hemang-Lower Denkyira District in the North and Bibiani-Anwiaso District to the West. The Upper Denkyira District covers a total land area of 1700 square kilometers, which is about 17% of the total land area of Central Region (3-Year D Plan for the Upper Denkyira District) (Map 1).



KNUST



3.1.2 Relief and Drainage

The relief of the area falls under the forest-dissected plateau (x), rising to about 250 m above sea level. There are isolated steep sided hills alternating with leveled bottom valleys. The District capital, Dunkwa-On-Offin, is encircled with series of highlands. The main river that drains the land is the Offin River. A number of streams that form the tributaries of either river Offin or River Pra flow through the district. Among the major tributaries include River Subin Ninta, Aponapon, Tuatian and Subin (3-Year Development Plan for the District, 2002).

3.1.3 Vegetation

The study area falls within the semi-deciduous forest zone. It is made up of three layers, which is similar to the rain forest. The trees do not shed their leaves at the same time and are of different species. The lower layer and some top most trees remain evergreen throughout the year. This is due to the generally moist condition of the area. Through man's activities (especially shifting cultivation, logging, fuel wood, and mining) the forested land has been reduced to secondary forest and bush. The forest contains various valuable timber species such as Mahogany and Wawa (3-Year Development Plan for the District, 2002).

3.1.4 Soil

The soil comprising mostly forest ochrosol, sandy clays and loam are deemed suitable for the cultivation of food and tree crops. The soil is not highly leached as oxysol. Due to the reduction in rainfall amounts the soil contains greater quantities of soil nutrients and is

generally alkaline. From the viewpoint of crop production, they are the best soil in the country. Tree crop such as cocoa and oil palm thrives in the area. Cocoa covers about 50% of the districts entire arable land area. Other crops such as cassava, plantain and maize also do well (3-Year Development Plan for the District, 2002).

3.1.5 Climate

The study area falls within the semi-equatorial zone with characteristics of a mean annual temperature of about 29 °C in the hottest months and about 24 °C in the coolest months. The area experiences a bi-modal or double maximal rainfall centered on June and October. The total annual mean rainfall is between 1200mmm and 2000mmm. The main dry season is from November to February (3-Year Development Plan for the District, 2002).

3.1.6 Population

According to the 1960 population census, the district population was 34011. Growing at rate of 2.8 % per annum, the population reached 44,498 in 1970 and by 1984 the total population was 68,329 showing an annual growth rate of 3.1% per annum. The 2000 Population and Housing Census put the district population at 108,444 (3-Year Development Plan for the District, 2002).

3.1.7 Ethnicity

The indigenous people of the area are the Denkyiras who form part of the Akan. They have over the years co-existed with several entrenched settler ethnic groups; prominent among them are the Ashanti, Fante, Akuapem, Ewes and people of the Northern

extraction. There exists a harmonious social relationship among these different ethnic groups as a result of tribal inter-marriage. The kinship system is of matrilineal lineage and thus inheritance is traditionally passed on from brothers to their sister's children (3-Year Development Plan for the District, 2002).

3.1.8 Physical Infrastructures (Roads and Railways)

The study area is easily accessible from some of the major towns in the country. Roads and railways link the area to Regional capitals like Takoradi and Kumasi. Other towns the district has a link with by road and rail include Obuasi, Tarkwa and Awaso. Internally the area has a good road network only that portions of these are not tarred with bitumen and are in a very poor and deplorable state. This has contributed to post harvest losses and high cost of foodstuffs in the district (3-Year Development Plan for the District, 2002).

3.1.9 Economic Activities

As in other rural area of Ghana the majority of those employed in the study area are engaged in agriculture especially in food crop farming and in some cases cash crops like cocoa and oil palm. This type of agriculture take place through the tradition land rotation in which land is allowed to rest (fallow) for three to six years in order to regenerate its fertility after a period of cultivation. The increasing demand for land for settlement, mining, logging and agriculture have shortened the fallow period and consequently left on its trail severe land degradation.

An interesting feature of farming in the study area is the practice of land tenure system. Basically the land is family-held by indigenous Denkyiras. However, increasing population pressure and the presence of large number of migrant farmers have led to the evolution of shared cropping or tenancy arrangement ('Abunu' and 'Abusa') and a system of land rental and leasing. Other economic activities of the area are mining, logging, and wood fuel collection and manufacturing, wood processing and general trading (3-Year Development Plan for the District, 2002)

3.2 Selection of the Area for the Study

The area chosen for the study is the Upper Denkyira District of the Central Region. The District has a total population of 108,444 (2000 Population and Housing Census). Farmers dominate it; most of which live in the five (5) major settlements. These are Chichi were, Ayamfuri, Oponso, and Diaso with Dunkwa being the District Capital. Larger percentage of the population relies on wood fuel; until recently only Dunkwa, the District Capital and Diaso had electricity, the rest were not connected to the National Electricity Grid. The main source of fuel for the study area has therefore been fuel wood supplemented by kerosene, and quite recently L.P.G (3-year D-Plan 2003).

Increases in the demand and supply of fuel wood are expected since the establishment of gari and starch factory in the District capital will use fuel wood as the major fuel. The present trends in the supply-demand situation suggest an intervention since the prices of fuel wood is increasing especially in the District Capital where wood fuel has higher market value.

The area was also chosen because fuel wood production is an established business practices that has gone on for a very long time in the study area, but the organizational structures in existence seems to be very poor.

3.3 Study Methodology and Data Collection

Data used in this study was obtained from two main sources: primary and secondary.

The primary sources included field survey, (Rapid Appraisal and Sample Survey) and personal observation and measurement.

The secondary sources included a review of existing literature on the socio-economic analysis of fuel-wood production and utilization of wood fuel sought from the study district, region, the country, and the world at large.

Five (5) approaches were employed in the study:

- Exploratory/Familiarization Visit
- Reconnaissance survey
- Socio-economic survey
- Informal personal interview
- Wood fuel measurements

3.3.1 Exploratory/Familiarization Visit

This was done during the preparatory stage of the study: three-day visit was undertaken to the field to familiarize with the officials and other key informants to hold discussion with them.

Key departments that have stake in wood fuel notably, Forestry, Food and Agriculture, the Cocoa Board and the District Assembly were contacted. The discussion briefed them of the impending research and how they could be of help to the study. Arrangements for the use of their resources such as libraries and expertise were also made.

3.3.2 Reconnaissance Survey

Four (4) days was used to undertake reconnaissance survey of the chosen communities.

The survey had three main objectives:

- To identify possible households/wood fuel producers from which random samples were to be taken for actual survey.
- To establish rapport/contact with some charcoal/fire wood producers in some of the chosen areas,
- To rapidly appraise some of the wood lot establishment in the area.

3.3.3 Socio-economic Survey

A structured questionnaire was used to obtain socio-economic characteristics of fuel-wood producers, traders and users: A cross section of producers, traders, users and woodlot practitioners from each of the selected community who availed themselves were interviewed. In all, 40 wood fuel producers, 115 household wood fuel users, 34, wood fuel trader / distributors and 17 woodlot practitioners were interviewed. Questions asked bordered on demographic features of households, labor allocation for wood fuel collection, decision making on fuel wood consumption and collection. Market survey conducted focused on the prices of charcoal and fire wood, supply and demand sources.

Other information that the questionnaire collected included the pattern of fuel-wood use and supply, channel of distribution, policy and institutional arrangements that affect the fuel-wood business and the general impact of fuel-wood on the livelihood of the inhabitants of the study area. The questionnaire was pre-tested and modified. The survey lasted for two weeks. The researcher was the sole conductor of this survey. A copy of the survey instrument (questionnaire) is provided in Appendix 1.

3.3.4 Informal personal interview

Questionnaire interview was followed by informal interview, which was used to collect additional information, which could not be obtained by the formal questionnaire method. Personal interview and discussions were held with the then operating sawmills, which were disposing off their saw residue to charcoal burners and other wood fuel users. These were: Afriyie Bretuo Ltd, Green Tree Ventures and Starke Lumber Co. Ltd. Two people from each sawmill were interviewed on:

- The type of wood residue that are produced
- How residue are disposed off
- To what use their residue are put
- What quantities of residue are disposed off

Personal interview with local authorities specifically the Upper Denkyira District Assembly, the Forestry Department and some Assemblymen and chiefs were also conducted. The interview bordered on aspects such as:

- Fees and taxes paid on charcoal and fire wood
- Producers acquisition of wood for charcoal and fire wood
- Perception of the environmental effect of charcoal and firewood production
- Status of tree growing effort by the government, institutions and individuals

Interview was also granted to institutions such as schools (secondary), hospitals, hotels and bakeries. The two (2) major hospitals that existed at the time of the research were Dunkwa Government Hospital and St. Stephen's Hospital. Three (3) secondary schools being: Boa-Amponsem Secondary, Diaso Secondary and Dunkwa Secondary Technical Schools were contacted for interview. The four (5) hotels/ restaurants in the District capital and ten (10) bakeries were selected for interview.

3.3.5 Fuel measurement

In this survey, daily household fuel consumption data was collected from all the five (5) chosen communities for the socio-economic survey. Ten (10) households who used wood fuel (firewood & charcoal), Liquefied Petroleum Gas (LPG), Kerosene and electricity in each of the five (5) communities were randomly selected for the measurements. Each household was visited twice a week to weigh the piles of wood fuel found and estimated the daily household consumption. Same measurements were taken for the other sources. The spring balance was used to take the wood fuel measurements.

3.4 Sample determination and sample size

The survey area is made up of four (4) main towns clustered around the district's capital (Dunkwa) and other smaller settlements. The main settlements are Chichi were, Ayamfuri, Oponso and Diaso. Charcoal and fuel-wood production is mainly from these four towns, Chichi were, Oponso, Ayamfuri and Diaso communities with populations of 15,000, 8,000, 10,000 and 12,000, respectively. Proportionate sample size was chosen from these communities. The basis for the choice of these communities included.

- Those communities that produce wood fuel for sale.
- Their nearness to the forest resources
- Those communities that are utilizing saw mill residue as materials for charcoal burning
- Those communities that produce wood lot
- Areas that make much use of wood fuel.

The table below shows the chosen communities and the sample of people selected for interview.

Table 3. 1 Sampled settlements and woodlot practitioners for socio-economic survey

Community	Consumption sample size	Production sample size	Wood lot practitioners	Wood lot sample size	Total
Dunkwa	50	7	4	2	63
Chichi were	15	10	18	5	48
Diaso	20	5	12	4	41
Oponso	10	10	5	3	28
Ayamfuri	20	8	6	3	37
Total	115	40	45	17	172

Source, field data 2006

3. 5 Data analysis method

The data collected from the study was analyzed quantitatively and qualitatively. The SPSS PC+, a statistical package was used for the analysis. Data was summarized in the form of frequency distribution tables, graphs, as well as statistical measure of central tendency.

The choice of the analytical tool was made based on the statement of the problem, objectives and the central theme (hypothesis) of study.

3.6 Constraints in data collection

The group of people that posed problem to the research was that associated with charcoal production.

A fear of tax assessment was rife with respondents especially the charcoal producers and sellers and in some few instances firewood sellers. It took prolonged explanation for them to understand that the exercise was purely an academic one before they opened up for interview, questions and discussion.

The drivers of charcoal and firewood trucks that were intercepted felt very reluctant to give any information on their activities. They also feared that any information released by them may lead to tax assessment. In most of such encounters the showing of my student identification card calmed them down.



CHAPTER FOUR

RESULTS AND DISCUSIONS

4.1 Introduction

This chapter discusses the data obtained from the field survey. The first part focuses on the characteristics of the main partners of the charcoal cycle in the study area.

Characteristics touched on include: age, educational status, household size, etc, as they influence the option to be in the wood fuel cycle or not. This is followed by a look at the production, consumption and marketing environment of the charcoal industry.

An analysis of the living condition of main actor of the fuel wood business is also reported. The last part of the chapter touches on the institutional arrangement, procedures that affect the charcoal industry of the study area.

4.2 Socio-economic characteristics of actors (Wood Fuel Producers, Users and Distributors) in wood fuel industry

4.2.1 Age Distribution

The mean age of producers of wood fuel (charcoal & fire wood) was about 28years. There is about equal number of young (5.4 percent) and very old producers (3.6 percent). The middle age (35-54 years) constitutes the greater proportion of producers that is about 54 percent.

The mean age of consumers of wood fuel was about 40 years. The use of the product by the young is almost the same as by the middle age.

The average age of wood fuel distributors/sellers was about 30 years. The study revealed that people of the middle age are much involved in the sale and distribution of the product. The observations are presented in table 4.1

Table 4.1 Age distribution of main wood fuel actors in the study area

Age Group	Producers	Sellers	Users
Less than 25	12	4	15
25-34	12	12	20
35-44	10	8	35
45-54	4	6	25
55-64	1	4	10
65 and above	1	0	10
Total	40	34	115

Sources; Field Survey, 2006, July

4.3.2 Religion

About 68 percent of the sample producers, users and marketers of wood fuel were Christians and 19 percent Moslem. There was lesser proportion of traditionalist about 9 percent (Table 4.2).

Table 4.2 Distribution of wood fuel producers according to Religion

Religion	Frequency	Percentage (%)
Christianity	128	67.7
Islam	36	19.0
Traditional	15	7.9
Non	19	10.1
Total	189	100

Sources; Field Survey, 2006 July

From the analysis the dominant religious organization is Christianity; this makes the various churches a good platform for the dissemination of any innovation to the actors of the wood fuel business. Moslems are also found in most of the communities the interview was conducted. About 19% of the population involved in the wood fuel business, and use mean a lot. In the zongo communities, higher numbers of Moslems are found as either, users or marketers. Traditionalists are also producers, users and marketers of either charcoal or/and firewood. In fact traditionalists by their nature are conservatives and are proponent for forest conservation. The percentage rate is about 8%.

4.3.3 Educational Status of Actors of Wood fuel

Generally the educational level of almost all the producers of wood fuel was low. The users had a relatively higher educational status and marketers (sellers and distributors) an average age value. About 45% of sample users have had education up to the secondary /

training college. 5% have had education up to the tertiary. About 30% have had it up to the middle / JSS level and 20% illiterate (Table 4.3)

Table 4.3 Educational Status of producers / marketers / user of wood fuel

Level of Education	Charcoal Producers	Charcoal Sellers	Charcoal Users
Illiterate	20	10	10
Primary	13	12	20
Middle/JSS	5	10	23
Tech/Voc.	0	2	32
Sec/Training Col	0	0	10
Tertiary	2	0	20
Total	40	34	115

Sources; Field Survey, 2006, July

The underlying reasons of the lower education of most producers and sellers may be due to poverty and lack of basic educational infrastructures in the study area. The consequences of this low level of education are the use of crude and old method of charcoal production such as the earth mound. All the respondents on method of producing charcoal said they use the earth mound.

4.3.4 Household Size

The inhabitants of the study area believed strongly in extended family system, their household size was determined by the husband, wife, children's and other dependants.

60% of the household of producers, marketers and users had eight (8) or more members.

Table4.4 Household type and size of wood fuel Actors Respondents

Type/Size of Household	Producers	Marketer/ Sellers	Users
Single	3	4	22
Small (2-3)	16	20	26
Medium(4-6)	10	16	39
Large(7+)	11	8	28
Total	40	34	115

Sources; Field Survey, 2006

More than 50% of respondents were in the 25 -34years age group, thus they are in their fertile period. It is worthy of note that families were already large with a mean figure of 6 members in a house. The impact of this is the increased pressure on the forest resources existing in an already fragile ecosystem of the study area evidenced by the deforested environment. Large family size as exhibited by the study is likely to relegate to the background conservation of forest resources. Nonetheless, the large family sizes serve as major sources of labor for the farming and fuel wood production.

4.4 Socio-economic environment of producers, distributors and users of wood fuel

The socio-economic environment of producers, distributors and users of wood fuel has been discussed on the broad framework of the socio-cultural and economic milieu of the study area. This discusses the needs, objectives and goals as well as the opportunities

and constraints of the stakeholder of fuel-wood. The impact of the business as reflected on the standard of living / livelihood would also be touched.

4.4.1 Mode of tree/wood acquisition

Land and tree in the study area is family held by indigenous Denkyira's. However, increasing population pressures and the presence of migrants' farmers and wood fuel producers have led to the evolution of share-cropping and tenancy arrangement: a system of rental or land leasing. Two types of this system exist, "Abunu and Abusa". In each case, the land owner leases the land to the prospective farmer wood fuel producer who is permitted to fell trees on the land for wood fuel. The harvest from both crops and biomass are shared between the land lord and the tenants. Leasehold and hiring of land for various periods can be arranged at various fees. Table 4.5 below shows the land/tree acquisition pattern for both farming and wood fuel purposes. Most of the indigenous wood fuel producer acquired their tree for wood fuel from family land i.e. 65%. This was followed by the leasehold and the sharing system that is 17.5% and logging residue 10% purchased land 5% the use of communal forest taking 2.5% with wood lot having no support.

Table 4.5 Mode of land acquisition by wood fuel producers in the study area

Mode of acquisition	Number of respondents	Percentage of respondents
Family land	26	65
Leasehold/share	7	17.5
Purchased land	2	5
Community land	1	2.5
Logging residue	4	10
Wood lot	0	0

Field survey, July 2006

Importantly, acquisition through family land and leasehold constitute the most common forms of tenure arrangement. This observation is very important given the fact that tenure arrangements in the study area restrict tenants in the use of land to cultivate tree crops and in felling trees for fuel. The share-cropping and the leasehold land provide a flexible means for migrants and poor and landless people to obtain land for farming and wood fuel production. It was observed that the system is also a potential source of conflict between tenants and land owners.

4.4.2 Availability of Logging Residue

As at the time of the research five saw mills were in operation. The hitherto defunct Thomson Moir and Galloway (TMG), which was back in operation, was the biggest milling firm, producing the highest saw residue. On the average each firm produced about 1-3 tractors load of residue in a particular day of production. The residues are

disposed off to charcoal burners, chop bar operators, and other individual household users. As at the time of the study the TMG was disposing off its residue to one of its workers for small fees. He in turn hire labor to burn the wood for charcoal.

4.4.2 Production of Charcoal

Firewood productions have been an occupation of most of the respondent of the study area. The production of charcoal was undertaken by only few and in some specific communities, although all the communities in which the study took place had people burning charcoal using the old earth/pit mound method. The study area is located in the semi-deciduous forest zone of the country, thus blessed with rich forest resources.

4.4.3 Major Wood Species Used

In the study it was revealed that even though all forms of wood could be used for either fire wood or charcoal certain kind of trees are preferred to others. In all the five (5) communities in which the research was done, the major and preferred tree species for fire wood and charcoal were mentioned as follow: ‘Ongo’ (Terminalia avicenioides), ‘Kane’ (Anogeissus leiocarpus), ‘Dahoma’ (Piptadeniastrum africanum) Denya, (Cylicodiscus gabonensis) “Odwe” (Baphia nitida) “Oyamedua”, Nyamedua, (Alstonia boonei), “Otennuro” (Trichilia manadelpha), “Kakapenpen” (Rauvolfia vanitoria), “Esa kokoo” (Celtis Zen Keri), Kokrodia, (Pericopsis clata) etc

In an era of shortage of the most preferred tree species, other inferior species served as important substitutes. It is worthy of note that not all charcoal producers get their wood

supply from live standing trees. Some got theirs from dead wood, land clearing residue, and logging residues / left over. It was also observed that none of the charcoal producers had his/her tree plantation, some however with indigenous idea about the importance of tree, allow and nurture already existing preferred trees species on their farms to be harvested when matured for wood fuel. All the trees were either sourced from the forest, which is considered as a free good or logging material by some handful that were lucky to stay close to saw mills.

4.4.4 Cost of Wood and wood fuel Production

The cost of wood for both firewood and charcoal was very difficult to assess by both firewood and charcoal producers, since most of them acquired the raw-materials without any cost. A special case in point was Diaso and Esikuma Communities where some commercial producers contended that they have permit which allow them to fell tree from a defined concession. On the average one mature tree costs ₦20, 000, and such a tree could produce an average of 10 minimum bags of charcoal. Labour cost was not also definite with some of them since they rely on family hands. Nonetheless, an estimate of ₦20,000 was given as the wage for the hired labour per day. The merchants and retailers who place order with charcoal burners, and often make some down payment mostly provide the sacks. Charcoal produced in the bush need to be carted to the buying centers, and this attracts transportation fees of ₦2,000 per mini bag carted between distances of 10 to 40km. In all the cost of a mini bag of charcoal ranged between ₦25,000-₦30,000 depending on its quality and distance covered in transporting.

4.4.5 Supply of Fire wood / Charcoal

Among all the communities visited almost all (90%) depended on one form of wood fuel or another (either fire-wood / charcoal). This demand, which is fairly inelastic, meant that there should be constant supply of the product. Most households fetched their firewood. They gather / collect this from their own farm and / or community forest without any cost during especially the weekend when children could assist parent on the farm because they do not go to school.

The supply of firewood to the commercial operator (food vender) was quite different. The food vendors that depended on wood fuel had their supply brought to them by wood fuel merchants and some times retailers. Some are brought by head load and some by trucks. The institutions as at the time of the study were also getting their supply of wood fuel from both producers themselves and merchants (wholesalers). There were also a sign of shifting from the use of firewood to charcoal and from charcoal to gas (L.PG). Table 4.7.shows this trend.

4.5 Gender Issues in Wood Fuel Production and Distribution

In almost all the communities visited both men and women were taking active role in the production and the distribution of the product (Plate 7). Their activities (trade) reach its peak after the planting seasons are over, where there are less farming activities. This period is normally after March to July. Children of school going age were also found to contribute a lot to the procurement of wood fuel in the communities of the study area. There were some few instances, for example, at Esikuma community where women and

children dominated the operation. This confirms the assertion by Hoskins that women have less money as they have fewer resources and less time for producing surplus items for sale or trade. (F.A.O, 1983, Hoskins).

School children during weekend and vacation assist their parent in fuel wood collection / gathering. The male counterparts however, are mostly involved in other responsibilities such as preparing the land for cropping, and so on.

Touching on the burning of charcoal, the study showed that women again take a very large share. In the Esikuma Communities almost all the processes, beginning from wood sourcing to the conversion to charcoal were done by women and children. In Diaso men and women were all involved. The males, often the husbands fell the trees and prepare them with their wives for carbonation. In some cases respondents indicated division of labour where the male produced the product in the village and cart them to the women at the urban centers for distribution / sale.

4.6 Pattern of Wood Fuel Production

The patterns of wood – fuel production and / or collection are important for study since this could afford us with the understanding of the organization of the business and the associated cost of wood fuel use. To understand these patterns, it is very important to have an idea of the composition of those involved in its production. The role of the household and other groups in wood fuel production are discussed.

4.6.1 Labour Allocation

In all the communities, female head and children, who were either male or female collected firewood? This was collected from their own farm and or the forest. The survey confirms the result of AFREPREN research which reveals that the allocation of labour on fuel wood collection is based on the magnitude of the opportunity cost of household labour. Such that members of the households with a low opportunity cost of labour such as children and women tend to be allocated the task of wood – fuel collection. The scenario is quite different for charcoal production in many communities. Male counterpart dominates the production of charcoal in the study area. There was an exception at Esikuma where female and children dominated in the burning of the charcoal (carbonation). The women who were mostly married people hired a chain saw operator to fell and cut the trees into pieces and there take over the rest of the work. In some situation smaller trees are felled by themselves by using the axe / cutlasses. Their male counterparts were mainly involved in palm wine tapping / local gin distillation.

4.6.2 Decision on Wood Collection

An enquiry into who made decision on fuel wood collection revealed that women dominated. This is consistent with the cultural expectation of the study area since women are supposed to be the main decision makers on household activities such as fuel wood collection.

In times of fuel wood scarcity the households rearrange their labour allocation in such a way that males could also take the responsibility in collecting fire wood with females.

Majority of the women who were found in the wood fuel business said their male counterparts do off-farm jobs.

4.6.3 Means of Transport

In most of the communities, fire wood and charcoal are conveyed to the home and market places by head load. There is often no accessible road to those places thus the use of portage and bicycle are common modes of transportation. Vehicles such as tractors, trucks are also used when the production area is motor able. This may be sold to a wood fuel merchant or group of people who have the means of transportation. The cost of transportation of this is put on the product when the product gets to the retailer or the consumer.

The cost of a head load of fire wood ranges between ₦10,000-₦20,000 and that of a mini bag of charcoal is between ₦25,000-₦30,000 depending on the type of charcoal (soft/hard) and the distance covered from the collection point to the market. Some of the wood fuel is conveyed outside the district to areas such as Obuasi where the demand for the product is greater.

The gathering of fuel wood is at it peak during the hamattan period and during the period that farmers have cultivated the season crops. Interaction with fuel wood gatherers indicated that they now have to cover longer distances than they did in the past.

4.6.4 Quantity of wood fuel Produced

The gathering of firewood was mostly from farmlands after preparation. Some also gather it from the forest reserve. It may also be sourced from the wild. Most of the households who collected their own firewood from their farm and other areas in the villages saw the product as easy to come by. They admitted that there was no shortage of wood fuel. In their estimation, only few without farms go to the market to buy it. Only few firewood sellers in the village markets evidenced this. Charcoal was quite different. It had a better trade since only few households produced it.

The fuel-wood situation in the per-urban communities however is different. Here, most households rely on market supply. Households who source the product from the forest and other farm lands have to cover long distances either by walking or by car before collecting/ gathering the product. This is due mainly to urbanization and pressure on land resources. In Ayamfuri which is an example of such places, interview with most farmers who use fuel wood said they could travel for about 5 miles before getting to the fetching place for firewood. In view of this they prefer buying the product when in need.

In the Dunkwa Township the situation becomes very worse sometimes. The demand is above supply and this had made the product expensive and scarce sometimes. An average head load of firewood that costs ₵10,000 at the Diaso costed ₵12,000 at Ayamfuri, same amount costs ₵15,000 in Dunkwa -Offin. The same situation exists for charcoal. A mini bag of charcoal (Denya) costs between ₵20,000-25,000 at Diaso but costs between ₵28,000-₵35,000 at Dunkwa Offin.

One of the traders showed a bunch of firewood she bought for ₦10,000 which has increased to ₦15,000 in just 5 months interval. They expressed the fear that the situation would be worse in the near future if nothing was done about it.

The saw mills found at the study area were supplying saw residue to charcoal operators commercial food vendors and households. This was not enough since there was always an order for the slabs, and some time there could be no supply of mill residues.

An interview with the management of the soon to open Gari processing factory hinted that the factory would rely on their own planted trees as a source of fuel. Liquefied Petroleum Gas (LPG) would also supplement this.

4.7 Earth Mound Charcoal Production

In the study area, all the charcoal producers interviewed used the traditional earth mound (Plate 5). The woods (trees) are generally obtained from felling trees on fallow land or trees on farmland. The branches are cut and mound trunks cross cut into billets of 1.0-15 m length the billet are arranged in a shallow pit or on the flat ground and then covered with grass and / or green leaves. In the saw mills, some charcoal burners preferred the sawdust as a means of covering the stacks. After covering the stack, fire is set into it through a small hole. Air inlets are allowed at vantage point for smoke exhaust.

The wood burns gradually until the end product is ready. An average mound may take 2-4 days to finish carbonation depending on the moisture content of the wood and the

softness of the wood. The charcoal is harvested and bagged into mini and jute bags for onward transport into the market.

4.8 Opportunities and constraints for Agro- Forestry

An inquiry into whether producers of both charcoal and firewood used their own planted tree or not revealed that majority of them do not practice tree planting meant to supply raw-material for wood fuel. Of the 40 producers interviewed, none produced his own tree (wood lot) for wood fuel production. Thirty-two (32) respondents who have knowledge of wood lot, and wished they could practice it gave various reasons which prevented them from practicing it. This underlies the fact that many producers of wood fuel in the study area acknowledged the potential of agro forestry but are unable to practice it because of their socio-economic status as tenants and migrants. Among these were, the fact that most trees take long period before they mature for wood fuel and other products, again some were of the view that since they do not own the land, undertaking such a venture may lead to land and tree tenure problems which may deny them the legal use it. Nonetheless, wood fuel producers who were also farmers said they do not fell economically valuables trees when weeding their lands for farming. Table 4.6 below indicates a detailed view of wood-fuel producers/ woodlot practitioners on tree planting (Agro-forestry)

Table 4.6 Assessment of the views of wood fuel producers/wood lot practitioners on tree planting (Agro forestry)

Reasons	Agro forestry practitioners*	Non Agro forestry practitioners*
Why can practice? Total	25	-
Had access land	8	
To obtain timber	12	
To obtain pole	18	
Environmental concern	4	
Wood fuel	3	
Sell such product for cash	16	
Why cannot practice? Total		32
Lack of land		15
Returns from tree planting is long term		10
Lack of commercial planting trees (e.g. teak)		13

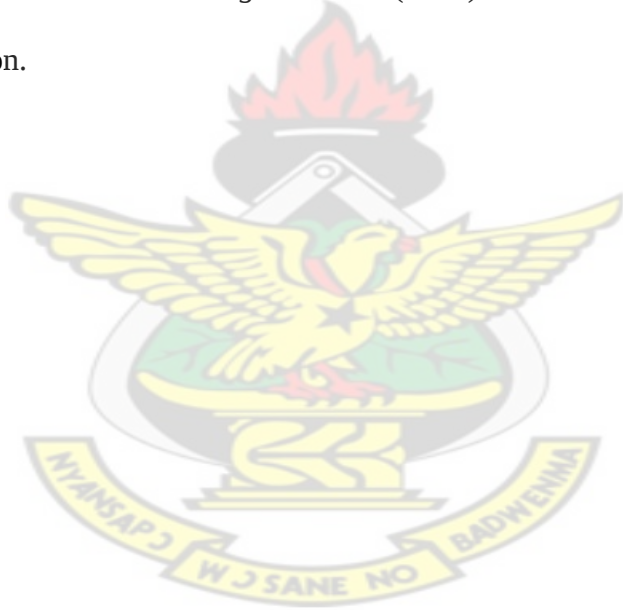
Sources: Field survey – 2006-June:

* Some respondents gave multiple reasons.

Practitioners cited various advantages they stand to get when they undertake the practice. Among these were: pole and cash obtaining the highest response. Other reasons indicated by respondents for adoption of agro forestry include: environmental protection, wood fuel, access to land. Intensification of extension education on agro forestry whiles redirecting research effort at improving existing technologies to meet the short term

needs of wood fuel producers could go a long way to stir up the desire of the respondents on practicing tree planting. This would attract and sustain the interest of practitioners, new entrants, wood fuel producers and land lords whose rational short term economic goals prevent any attempt at land conservation and sustained future yield.

The 17 practitioners of the tree planting who were intentionally selected gave similar reasons for undertaking the venture. Of the number, 75% gave the reason of access to their own land as the leading reason for the project. Other reasons included cash gain and pole production. Species like *Tectona grandis* the (Teak) were the major tree species that were under plantation.



Wood fuel movement from production points to supply areas

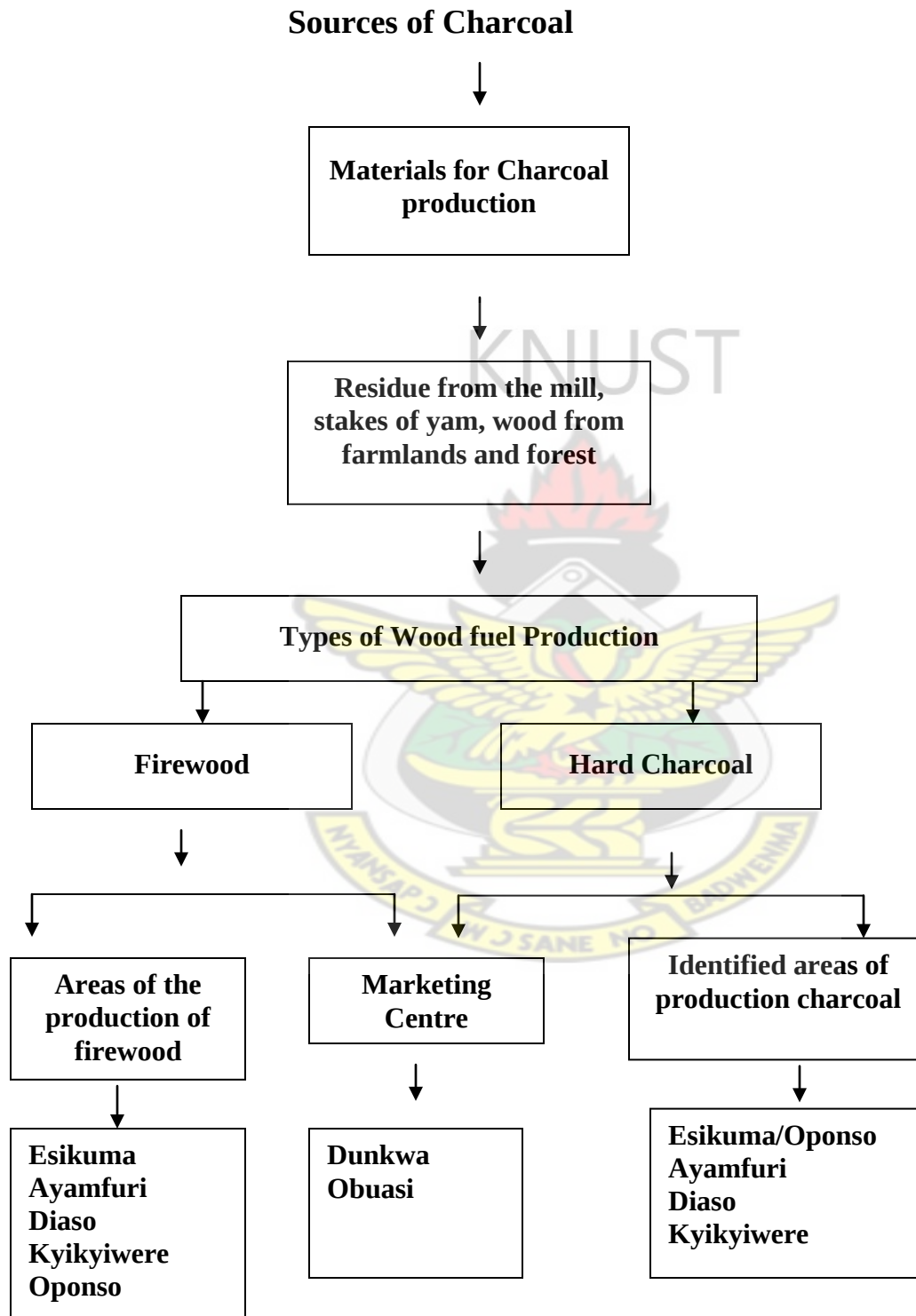


Fig. 4.1 Organizational Chart of Wood fuel in the study area

The study revealed that charcoal producers undertake their work at locations where wood is abundant, and there is permission to that effect. After the carbonation is over, the producer sometime hire labour to head load the bags of charcoal to the nearest point along the motorable road. The hiring charges are usually dependant on the size and weight of the load, and the distance actually covered on foot/ by vehicle. On the average, the head loading charges levied on mini bags of charcoal weighing between 15- 20kg ranges from ₦3,000 to ₦5,000. It is a normal practice to pass on the expenditure incurred in loading charcoal to the nearest motor able road to the buyer.

There is also the situation where tractors are used to convey bags of charcoal and fire wood from producing points to the nearest road. This is prevalent at Chichi were.

Another situation encountered was that large quantities of the charcoal are brought to the district which is in the Central Region from the western region, where the Upper Denkyira District shares border with. Some Western Region villages located along the boarders of the upper Denkyire district supply large volume of charcoal to supplement that produced in the district. Trucks were found bringing the product into the district.

Another scenario encountered during the research was that some producers occasionally cart their product to neighboring towns outside the District. An interview with one charcoal dealer said that sometime demand in the town reduces; thus there was the need to source for other markets and potential demand areas. Obuasi and the surrounding towns all in the Ashanti Region were some of the beneficiaries. Demand for the product

is better often at Obuasi than at Dunkwa he added. The movement of the volume of the product at a point in time could be seen in the flow line chart. (Fig 4.1).

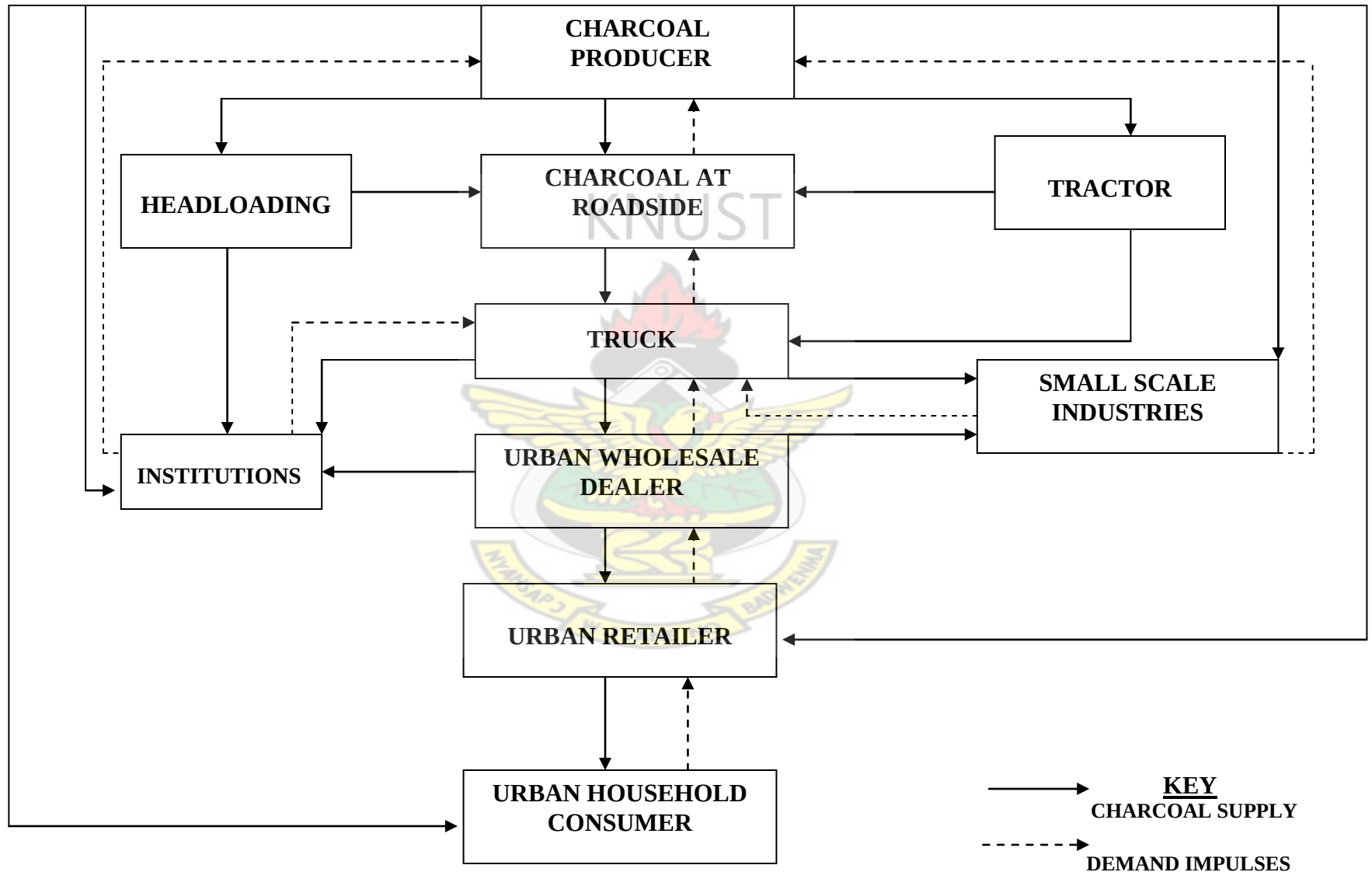
4.9 Actors in the Charcoal Trade

In every manufacturing business, the entrepreneur aims at making profit. The manufacturer produces and makes sure that the produce reaches the final consumer. The main actors detected in the charcoal / fire-wood trade included: producers, charcoal / firewood merchants, (Middlemen / dealers), retailers and consumers, all of whom are linked by various kind of transportation mode.



Figure 4.2

MODE OF CHARCOAL MOVEMENT FROM PRODUCER TO CONSUMER



4.9.1 Charcoal Merchant

Of all the distributors contacted, the middlemen had the least members, consisting of middle aged men and women. Some of them provide inputs like chain saws, axes, sack to the wood fuel producers who are then supposed to produce solely for them. They may arrange for or own their personal means of transport to cart the produce to agents in the urban centers or directly to the consumers. Wood fuel is procured from producers in large quantities and at cheaper prices.

4.9.2 Retailer

Majority of people were involved in this category. They get their supply from wood fuel merchants (wholesalers) according to the requisition placed by the various retailers. Apart from few cases where retailers were full time fuel wood sellers, most of the retailers were supplementing other income generating activities with this. Some of these retailers were public/ civil servants, house wives, and self-employed individuals. A retailer makes only a small turnover on every bag of charcoal and a bunch of fire wood sold to consumers. Some of the wholesalers allow the retailers to purchase them on credit basis coming for the money when the next consignment is supplied, in probably in a week or less time period. Retailers at the time of the study were breaking and selling both fire wood and charcoal in bits of ₦2000 some bagged in rubber and some containers.

4.9.3 Consumer

Consumers of the products ranged from the household, to those who used them for commercial purposes like food vendors, bakery, restaurant, etc. Very little was consumed

by commercial food operators and other institutions since they were not many at the time of the research.

The table below gives the volume of the various fuel used by the various institutions (excluding lighting).

Table 4.7 Institutional Consumption of various forms of fuel

Institutions	Number of respondents	Charcoal %	Fire wood %	Gas %	Electricity %	Kerosene %	Total %
Hospital	2	10.5	10.5	65	8	6	100
Sec. School	3	40	10	40	5	5	100
Hotel	4	23	18	45	10	4	100
Bakery	10	0	64	35	0	0	100
Household	115	36.4	18.5	19.4	10.6	15.1	100

Source: Field Survey, July, 2006

From the data collected most of institutions including most households were switching from the use of wood fuel to liquefied petroleum gas (LPG). Electricity was patronized minimally for cooking and heating purposes by all the institutions, i.e. 8%, 5%, 10%, 0% and 10.6% by hospitals, schools, hotel, bakeries and household respectively, the reason given was its comparative high price. Charcoal and firewood were used as supplementary fuel but had before the introduction of liquefied petroleum gas (L.P.G) been the leading and preferred fuel at the time of the research; they were contributing 21%, 50%, 41%, 65% and 54.9% at the hospitals, schools, hotels, bakeries and households respectively.

More than half of the bakeries interviewed still wanted to use fire wood as their main fuels. Although liquefied petroleum gas had a favorable preference especially the schools, hospitals, households and hotels. Some respondents gave the reason that liquefied petroleum gas is not reliable in terms of accessibility, and that users have to travel to the next town, Obuasi before they could buy liquefied petroleum gas (L.P.G). As at the time of the study, however, one liquefied petroleum gas (LPG) station had started supplying gas to the district, another one was nearing completion. Both are located at a suburb called Atekyem in the district.

Information from one of the secondary schools, Boa Amponsem revealed that although, the school relies on purchased fire wood, the school wood lot supplements this occasionally. The school recently harvested a lot of trees on the compound and was using this as a supplementary fuel to liquefied petroleum gas (L. P. G). From the analysis, one could realize that the commercial and institutional use of wood fuel (charcoal, fire wood) be discouraged if liquefied petroleum gas (L.P.G) could be reliable and produced in commercial quantities to the district.

4.9.4 Fuel Preferences by Households

Given the option, household preferences and the reason of choice for the various fuels were as shown in the table 4.8 below. The same data is given according to income group in table 4.9

Table 4. 8 Household Preferences for various Fuels

Fuel type	Main Reason for Preference					Total
Preferred	Safety	Cheap	Availability	Fast	Neat	percentage
Charcoal	33.4	24.6	16	13	1	36.4
Fire wood	26.4	38	28	15	—	18.5
Kerosene	35	25	15	18.3	—	15.1
Gas(LPG)	5	10	5	40	33	19.1
Electricity	5	4	10	58	32	10.6

Sources: Field Survey, 2006 June

The study revealed that the most preferred fuel type by respondents was charcoal (36.4%), followed by liquefied petroleum gas (LPG), (19.1%) and fire wood, (18.5%). The least preferred was electricity (10.6%). About fifteen (15%) said they preferred kerosene to any other type of fuel. Various reasons were given for the indicated preferences. These include safety of use, availability of fuel type and the speed with which they cook foods, cost and neatness of use. Out of those who preferred charcoal, 33.4% said they use it because it was safe, 24.6% said it was cheap and 16% said it was readily available. With respect to fire wood, as much as 38% used it because of its low cost. This was followed by its availability, 28%. Kerosene received 35% for its safety and 15% for its availability. Regarding liquefied petroleum gas, 40% use it because it is very fast compared with other types of fuels. Its safety received as low as 5% of respondents' support. Electricity, though had the highest preference regarding the fastness of cook, was seen as the expensive type of fuel. There was all indication that when the liquefied petroleum gas becomes accessible

and affordable, majority of households and commercial users would switch to its use. The indicated choices for the various sources apart from the given reasons by the respondents could also have been determined by perception of availability and cost involved in their acquisition. Again, familiarity or otherwise with various fuel sources will also be a factor; this will in turn depend on the kind of area one is located, that is either village or urban town.

The figure below illustrates the comparative preference of households expressed for the various fuel types at their disposal.

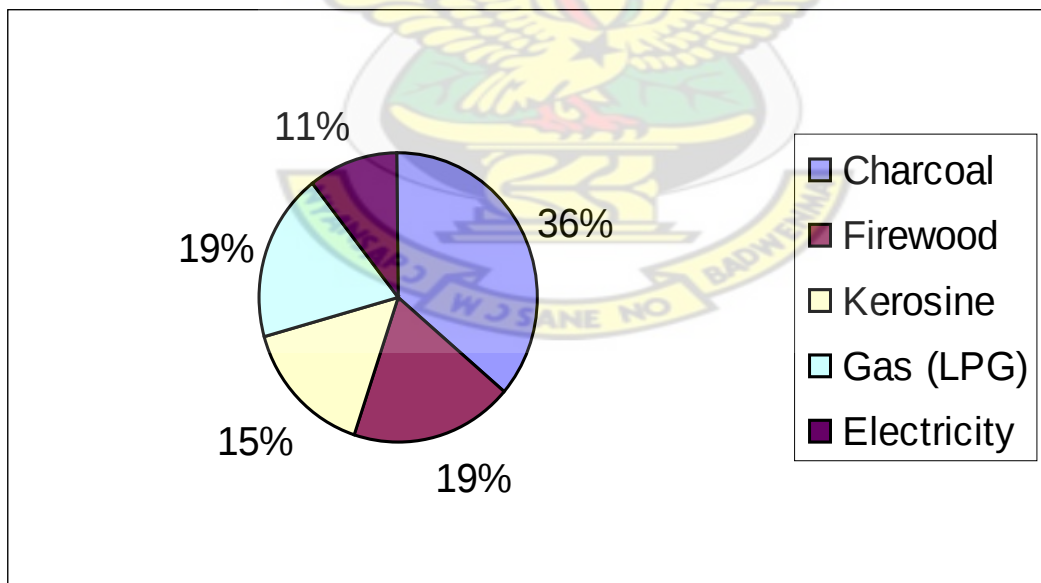


Figure 4.3 Comparative fuel preferences by the household.

Income received by the household were sampled and grouped into low, middle and high. ₦1,000,000 and below as low, above ₦1000, 000 to ₦5,000,000 as middle and above ₦5,000,000 as high. It is very clear from the table below that wood fuel (fire wood & charcoal) had a commanding preference by all the income groups. Charcoal was however preferred to fire wood. High income groups preferred and used gas more than all other energy/ fuel source. Reasons for the preference and use for gas was it fastness, neatness and accessibility at the time of the research.

Table 4.9 Household Fuel Preference by Income Groups

Preferred fuel	Percentage (%) of Household in		
	Low income	Middle Income	High Income
Charcoal	45.5	31.4	26.1
Fire wood	33.3	15.5	6
Kerosene	5	13.2	12.7
Electricity	3	18	19.1
LPG	10	21.9	36
Total	100	100	100

Sources: Field Survey, 2006 June

4.9.5 Magnitude of Household Consumption

The daily wood fuel consumption was estimated for all the five selected communities. Table 4.10 gives the average consumption wood fuel (firewood& charcoal) in the study area.

Table 4.10 Daily Magnitude of wood fuel consumption by households

Community	Fire wood (kg)	Charcoal (kg)	Average total used (kg) (fire wood & charcoal)
Dunkwa	4.0	3.1	3.55
Ayamfuri	4.4	3.5	3.95
Kyikyiwere	4.5	3.6	4.05
Diaso	3.9	3.4	3.65
Esikuma/Oponso	4.3	3.7	4.0
Average total	4.18	3.46	3.84

Field survey: June, 2006

4.9.6 Household Expenditure on Fuel

The daily per capita household expenditure on charcoal ranged from a low value of ₦1000 in Diaso to as high as ₦1,270 in Dunkwa – On –Offin where prices are often higher (Table 4.11). Fire wood figures were also low at Diaso and higher at Dunkwa; this trend was the same for all the communities for wood fuel, indicating an increasing cost of fuel (cost of living) from rural and less urbanized areas to towns and urbanized places. The cost of other fuel such as kerosene and liquefied petroleum at the villages were quite higher taking into consideration the transportation expenses. From the study, charcoal emerged as the most expensive fuel to the urban household. Using an average daily /person charcoal consumption figure of ₦1,174, and a fire wood of ₦656 it is realized that an individual person may consume a total of ₦428,510 and ₦239,440 of charcoal and fire wood, annually respectively. Using the average household size of 6 people the household

could then spend about ₦2,600,000 per capital (charcoal) and ₦1,436,640 (fire wood) annually. Wood fuel measurement (Table 4.10) gave an average household consumption figures as 4.18 kg for fire wood and 3.46 kg for charcoal per day for the study area. The combined average (wood fuel) is 3.84 kg. As expected the average daily household consumption was higher in dry season periods than in wet season due to space heating, this figures translate into about 1,263kg (1.2 tones) for charcoal and 1,526 kg, (1.5 tones) for fire wood annually for households, given an annual average total wood fuel (firewood and charcoal) consumption of households as 1,402 kg(1.4 tones).

It is worth noting that the above consumption figures seems to be within the range of those of AFREPREN biomass study (Kgathi; et, al 1994), where rural communities in Botswana consumed an average fuel wood of 4.8 kg per household daily.

It is useful to mention that the consumption of twigs and other parts of trees perceived to have a low preference fuel wood, such as small branches and roots, was impossible to measure since household did not always stockpile them, but instead used them immediately after collection. The comparative figures for daily per person per meal household expenditure on various fuels are given in table 10 on a per capita basis.

Table 4.11 Comparative daily fuel expenditures per person bases

Communities	Charcoal¢	Fire wood ¢	Gas (LPG) ¢	Kerosene¢
Dunkwa	1,270	855	950	830
Chichi were	1,150	645	1,000	----
Diaso	1,000	590	1,200	1,000
Oponso/Esikuma	1,250	555	1,200	940
Ayamfuri	1,200	650	1000	850

Source: Field Survey, 2006, June

4.10 Institutional Arrangements, Procedures Affecting Wood Fuel

The study looked at whether certain arrangements such as laws and tree/ wood acquisition procedures affect the production, trade and use of wood fuel (table 4.12). With consumption, most respondents 57% did not know and have no idea whether there is law and regulations restricting the use of wood fuel. This was followed by distributors, 32% who also did not know about environmental regulation limiting their business. Surprisingly, greater proportion of producers (55%) did not know any law or a regulation that places limitations to their business. Only 33% admitted that laws and regulation placed a limit on their operations. About 13% did not know of any laws restricting their work. Asked to mention some of the laws and regulations confronting their operations and their impacts, greater part of them mentioned the tenure arrangements with the land and tree owners. Mention was also made of the occasional patrol by some forest guards whom according to some producers arrested them for wrongful felling of trees. The distributors

(excluding the wood fuel merchants) paid the usual poll taxes which are also paid by any other seller, but the Forestry Department has a policy that registers all commercial legal wood fuel operators such as wood fuel merchants and distributors. Wood fuel merchants that is, those who deal in trucks and large scale distribution are made to pay a special fine to the district assembly. They have certificate that allowed them to deal in large scale distribution. Some producers had permit, (registered chain saw) that allows them to operate in a specified forest concession. Trees in the forest reserves and some plant species were not permitted to be felled except under a special permit issued by the Chief Conservator of Forest with the approval by of the Forests Commission. A person who contravenes the regulation commits an offence punishable by the law. Arrangement also existed for some producers and the inhabitants of an area to have access to the disposal of log residue for wood fuel. This is where a contractor's operation had ceased.

The existed tree tenure system allowed individuals to fell tree outside his legally owned land but at a fee. The value of the trees depends on the type of species. Landlord did not give permission to the fell of economically valuable timber tree such as Odom, mahogany for wood fuel as it is an offence of the Forest Commission.

**Table 4.12 Responses on the existence of environmental regulation affecting wood
Fuel business**

Actors/Players in Wood Fuel Business	Is there environmental law?(number of respondents)						Total
	Yes	%	No	%	Do not know	%	
Producers	13	32.5	22	55	5	12.5	40
Distributors	12	48	5	20	8	32	25
Users	16	13.9	34	29.6	65	56.5	115

Sources: Field Survey, June, 2006

The responses to the above question suggest that majority of the actors of wood fuel are not conversant with environmental laws regarding the production, distribution and use of wood fuel in the district. Information from the district Forestry Department revealed that although there are environmental policies existing in the study area regarding tree harvesting and air pollution, these laws are often flouted especially by commercial wood fuel producers. Offenders of the law when arrested are prosecuted and fined to deter others from the practice. Some of the actors were of the opinion that the permit given by the Forestry Commission to produce wood fuel takes care of all environmental fines/problem, and that after acquisition of the document, one is free to operate the business: Wood fuel producers are not compelled by the Forestry policy to plant tree to replace the felled ones. Retailers pay their normal land poll (a form of tax) as all other market women pay. They do not have to get a permit before they could sell.

On whether wood fuel actors have formed any association to spearhead their cause, the study found that there was no feasible formal group/ organization for any of the actors (producers, distributors and consumers). This makes it very difficult for them to have a platform to make their grievances known to the general public and the government. Education on policies, innovations would also be difficult if not impossible since the major stakeholders are not well organized.

4.11 Economics of the Charcoal Cycle

There is little or no price variation in charcoal with regard to the species or quality. The charcoal from any part of the study area attracted similar prices in a given market with regard to distance of supply.

The final (retail) prices of charcoal the consumer is composed of the following charges: cost of production, transportation charges, taxes, margins to the producer, transporter, dealer (merchant, wholeseller) and the retailer.

4.11.1 Production Cost

The cost of producing charcoal is dependant on the area and the method of production and the type of wood used. During the study a mini bag produced from the forest cost ₦25,000, and the same quantity but coming from the mills cost ₦28,000.

The percentage share of the component cost of wood fuel production may differ by reason of the method used, the distance of the market from the production spot, whether the wood was sourced from, (forest or the saw mills) and labor. The earth mound method of

producing was the one used to do this calculation. Charcoal from sawmills residue has a higher component of wood cost, ranging between 50% –70% of the final retail price. In the forest this is very low, not responsible for even 10% of the final price. Labour is very small for sawmill charcoal, accounting for about 12%, with the forest taking more than 15% of the final retail price of charcoal, this low figure at the sawmills is due to the less preparation required for saw residue. Cost due to transportation may arise from two areas: i.e. from the production site to road via head potorage, tractor and from road side to the market. For example, a mini bag of charcoal transported from Diaso to Dunkwa costed between ₵3,000-₵5,000. In all, transportation charges may account for about 5-10% of final retail price of charcoal depending very much on distance, road quality and the market. Taxation on wood fuel is very small ranging between 2-5% on per bag bases as depicted by table 4.14.

Table 4.13 Average share of the component cost of wood fuel production

Component (Items)	% cost range
Wood	72
Labor	12
Transport	6
Tax	5
Others	5

Sources: Field Survey, June, 2006

4.11.2 Income Generated by the various actors of wood fuel business

Data from the saw mills was preferred to those from the non saw mills in the calculation of income figures. The main reason being the reliability of saw-mill data as compared with data from the natural forest for charcoal and fire wood production. The cost components of wood fuel (charcoal and/ or fire wood) is not monetized, giving room for a lot of speculation and assumptions. For example labor cost was inaccessible since this was purely a household affair that attracted no fee. Again the cost of tree / wood for most of the production was difficult to calculate since most of them were acquired without the legal permit granted by the Forestry Department.

a. Producers Margin

Producers which were dominated by women and children in most of the study areas have by far the highest income margin. This may account for about 50-60% of the final consumer price of the product.

b. Wholesalers Margin

The wholesaler who buys in bulk (number of bags) and distributes them in bit (few bags) to retailers gains a margin in the neighborhood of 10-15% of the final price. The margin includes the merchant's income and overhead charges like the cost of empty sacks. This may range between ₦4500 -₦5000 on per bag bases.

c. Retailers Margin

This segment of charcoal actors which is dominated by women retailer sells the product in a sizeable portion. The margin includes wages and handling charges. This ranges between

20-25% of total cost price of a mini-bag (i.e., ₦7000- ₦10,000 cedis). It is important to note that profit margins from the non-saw charcoal will be higher since the wood may be obtained free of charge. The average income per a mini bag per, the retailing of a bag of charcoal is calculated below (Table 4.14).

Table 4.14 Gross Margin Profit to Charcoal Retailers

Community	Cost price/kg (₦)	Selling Price/kg (₦)	Gross marginal profit/kg (₦)	Weight range/mini Bag (kg)	Estimated Income/bag (₦)
Dunkwa	1,000	1,500	500	20-25	11,200
Chichiwere	840	1300	460	20-25	10,304
Diaso	850	1200	350	20-25	7,840
Oponso/Esikuma	850	1200	350	20-25	7,840
Ayamfuri	900	1400	500	20-25	11,200

Field Survey, July 2006

From the forgoing analysis, it is apparent that generally no actor in the charcoal makes any windfall profit / gain.

Charcoal prices are very high compared with other alternatives sources of domestic energy. This may be due to inefficiencies in the charcoal cycle.

4.11.3 The General Living Conditions of the Wood Fuel Dependants

In general, the pattern of life in the study area is highly influenced by the subsistent nature of the economy. This is characterized by low agriculture production, low income and the

associated poverty. In fact apart from few respondents who were salaried workers, almost all of the respondents depended solely on agriculture and other petty trading activities for their livelihood. Apart from the District Capital, Dunkwa-On –Offin, all the communities lacked most of the basic socio-economic amenities such as electricity, good pipe borne water, motor able road and standard basic schools and health facilities.

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CHAPTER FIVE

SUMMARY OF FINDINGS AND CONCLUSION

5.1 Introduction

This study has provided interesting insight into the socio-economic analysis of wood fuel production and utilization in the study area. The purpose of this chapter is to give a summary of the main findings, recommendations as well as an overall summary and conclusion.

5.2 Findings

The principal findings of the study are as follow: The main deciding factors for wood fuel production are:

- 1) Domestic use for cooking, heating, baking and commercial use such as for local gin distillery and large scale food preparation for schools and restaurants. Wood fuel is by far the most widely used energy source of the District.
- 2) Both producers and users of this energy source do not plant their own trees. The production base is therefore at the risk of depletion in the near future if the trend is not changed.
- 3) Tree planting is undertaken by few people who at the time of the research were not wood fuel producers. In fact, these were found in a group who are elite. All the seventeen practitioners interviewed had a better socio-economic status compared to most of the producers and distributors. The issue of Agro forestry technologies was news to most producers. Some have however indigenous knowledge about the practice, evidenced by leaving some trees on their farm for fuel wood and shade.

4) The production of wood fuel in the study area is under taken by both female and male.

The production method was basically the earth mound type. In both domestic levels, children and women dominated the business. The sale of the product is widely done by females, who do this not only in the markets but in all vantage points.

5) Some of the socio-economic benefits of the production, distribution and use of wood fuel were identified as employment opportunity and income generation to producers and marketers of the product. Almost half of producers and sellers, 48% and 44% respectively of the respondents got about three-quarters ($\frac{3}{4}$) of their income from wood energy. The households that source their energy from wood and twigs collected from the farms and other places save income (production cost) substantially to the tune of almost ₦7000 in a day.

5.3 Recommendation

The most significant findings of the study are that although fuel-wood is the main source of energy in the area, little or no attempt has been made to produce the raw-materials of wood fuel. It is suggested that the planting of trees be encouraged to forestall any future shortage/ crisis of wood fuel in the district. The use of indigenous earth (pit) method for producing the product should be discouraged and the new method introduced, for example the kiln used in Dabuse in the western and some part of Ashanti Region is recommended. This could be done by the district bringing all charcoal and firewood producers into one umbrella and teaching them the modern and the improved method under pilot study.

The households' use of both charcoal and firewood is also not efficient. A lot of the products go waste during use. Most of the cooking/stove devices identified were the old

type. The new improved cooking stove, popularly called Ahebenso and Japa should be introduced to the people; this could cut down the waste.

5.4 Summary and Conclusion

The study has been premised on the central theme that, producers of fuel wood do not produce their own tree plantation for wood fuel. Most of the producers and users of wood fuel are aware of the increasing degradation/shortage of wood for their product, their attitude toward conservation programmed activities such as tree planting portrays that of a typical resource poor farmers who when faced with limiting factors such as finance, land and skills uses the immediate, cheapest means of attaining livelihood without any consideration of the long term effect on his production base or the environment.

The planting of trees for the production of charcoal and fire-wood has not been the dream of the producers and users of wood fuel. The perception of the risk of losing tree plantation to land lord, and government and the long gestation period of the product are the major hindrance and discouraging factors. The situation is compounded by the fact that some of the producers of charcoal are migrants and tenants who have little control over land. Producers of charcoal and fire wood are considered to be poor in the study area and may not get credit facility for the creation of their raw-materials (wood lot).

Finally to conclude, it must be emphasized that, the adoption of tree planting by charcoal and firewood producers could be successful if stringent measures are adopted in the study

area by making available credit facilities to prospective tree planters, making available land and quick growth and quality wood fuel plants to them at affordable or no cost.

Research effort directed at investigating how to encourage the adoption of tree planting by fuel-wood producers is very imperative.

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QUESTIONNAIRE FOR MSc AGROFORESTRY THESIS.

TOPIC:

SOCIO-ECONOMIC ANALYSIS OF FUELWOOD PRODUCTION AND
UTILIZATION IN THE UPPER DENKYIRA DISTRICT OF GHANA

FIREWOOD PRODUCERS

Personal Data

1. Name of respondent.....
2. Age.....
3. Sex: Male ☐ Female ☐
4. Marital status: Single ☐ Married ☐ Widow ☐
5. Educational level: illiterate ☐ Primary ☐ Middle/JSS ☐ Technical/
Vocational ☐ Secondary/ Training College ☐ Tertiary ☐ Others specify ☐
6. Household size: i) 1-3 ☐ ii) 4-6 ☐ iii) 7-10 ☐
7. Main occupation:.....Cash obtained:.....per year
8. Minor occupation:.....Cash obtained:.....per year
9. Religion: Christianity ☐ Islam ☐ Traditional ☐
- Others, specify.....

INFORMATION ON FIRE WOOD PRODUCERS

1. Are you a full time or part time producer of firewood?

Full-time ☐ Part time ☐

2. If part time, what other job do you do?

3. 19. How do you get your wood? From: Community forest ☐ Agro

forestry ☐ Sawmill residue ☐ Bought trees ☐ Others

specify.....

4. Do you get wood near by or some distance away?

Near by ☐ Away ☐

5. If away distance from home what is your mode of transportation of wood to sale point?

Head loading ☐ Tractor ☐ Commercial vehicle ☐ Others specify

.....

6. If by head loading, which type? Family ☐ Hired labour ☐

7. If by hired labour how many people do you take at a time?

i) 1-3 ☐ ii) 4-6 ☐ iii) 7-10 ☐

8. How much do you pay each person per day?

¢.....

9. What kind of organization or association is fire wood production based on?

Family ☐ Cooperative gang ☐ Others ☐ specify.....

10. If you transport wood to production point by either tractor or truck,

please state

Cost of transportation. i) ¢5000-10000 ii) 11000-15000 iii) 20000 and above

11. What tree species is preferable and why?

.....

12. What environmental problem do you think is caused to the areas of operation?

.....

13. What tenure problems do you face?

.....

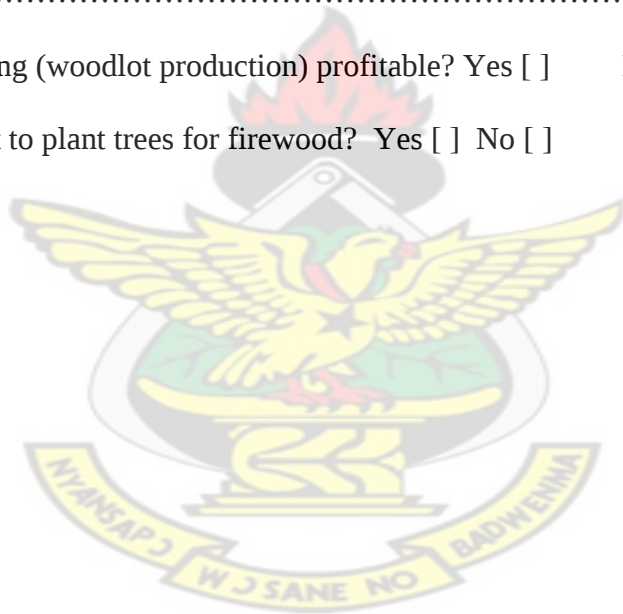
14. Do you need permit before trees are harvested /fell? Yes [] No []

15. Do you plant trees? Yes [] no []

16. If no why?

17. Is tree planting (woodlot production) profitable? Yes [] No []

18. Do you want to plant trees for firewood? Yes [] No []



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QUESTIONNAIRE FOR MSc AGROFORESTRY THESIS

TOPIC:

SOCIO-ECONOMIC ANALYSIS OF FUELWOOD PRODUCTION AND
UTILIZATION IN THE UPPER DENKYIRA DISTRICT OF GHANA

MARKETING AND DISTRIBUTION OF FUEL WOOD

PERSONAL DATA

1. Name of respondent.....
2. Age.....
3. Sex: Male ☐ Female ☐
4. Marital status: Single ☐ Married ☐ Widow ☐
5. Educational level: illiteracy ☐ Primary ☐ Middle/JSS ☐ Technical/
Vocational ☐ Secondary/ Training College ☐ Tertiary ☐ Others specify ☐
6. Household size: i) 1-3 ☐ ii) 4-6 ☐ iii) 7-10 ☐
7. Main occupation:.....Cash obtained:.....per year
8. Minor occupation:.....Cash obtained:.....per year
9. Religion: Christianity ☐ Islam ☐ Traditional ☐
Others specify.....

INFORMATION ON MARKETING AND DISTRIBUTION OF FUEL WOOD

1. Where do you sell your charcoal?

Production site ☐ Road site ☐ Market ☐ Others specify.....

2. Who do you sell your charcoal to? Wholesalers ☐ Retailers ☐ Consumers ☐

Institutions ☐

3. How much do you sell your charcoal/ firewood?

Location	Mini Bag		Maxi Bag		Jumbo Bag	
(Selling site)	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
Production						
Road side						
Market						

4. Is wood fuel becoming difficult to get compared with five years back?

Yes ☐ No ☐

5. If yes explain.....

6. Are there logging activities near your site? Yes ☐ No ☐

7. How far away.....Km

8. Do you like to use logging residue if available? Yes ☐ No ☐

9. Would you be interested in cultivating trees for your work? Yes ☐ No ☐

10. If yes under what condition.....

11. How many family members are helping in the business?

i) 2 ☐ ii) 3 ☐ iii) 4 ☐ iv) 5 ☐

12. Is this your only job? Yes ☐ No ☐
13. If no, what else do you do?
14. How long have you been in the fuel wood business?
15. Who are your main customers?
- Households ☐ Schools ☐ Prisons ☐ Hospital ☐ Retailers ☐
- Others (Specify)
16. How do you sell it?
- Bag ☐ Head load ☐ Small measure ☐ others (Specify)
17. How often do you get your supply?
- Daily ☐ Weekly ☐ Fortnightly ☐ Monthly ☐
18. What average quantity do you get each time?
- i) 1-5bags ii) 6-10 bags ☐ iii) 11-16 bags ☐ iv) 17-20 bags ☐
19. How is it brought to you?
- Truck ☐ Others (Specify)
20. What average income is received annually from your business?
- i) 100-200thousand cedis ☐ ii) 300- 500 thousand cedis ☐ iii) 600- 1mill cedis.
21. Do you pay taxes? Yes ☐ No ☐
22. If yes in what form?
23. Rank the main problems in the business as 1,2,3...
- Funds..... Supply Transport Others (Specify)
24. Is there any assistance coming from anywhere?.....
25. How best do you think the Government can help you or people in the business?
-

26. Is there any policy, laws, bye-laws governing fuel wood trade in the area?

Yes [] No []

27. What is the nature of the market over the last 5-10yrs?

i) shrinking [] ii) stable [] iii) expanding []

28. What has accounted for the choice associated?

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QUESTIONNAIRE FOR MSc AGROFORESTRY THESIS.

TOPIC:

SOCIO-ECONOMIC ANALYSIS OF FUELWOOD PRODUCTION AND
UTILIZATION IN THE UPPER DENKYIRA DISTRICT OF GHANA

FUEL-WOOD USERS (fire wood and charcoal)

Personal Data

1. Name of respondent.....
2. Age.....
3. Sex: Male ☐ Female ☐
4. Marital status: Single ☐ Married ☐ Widow ☐
5. Educational level: illiterate ☐ Primary ☐ Middle/JSS ☐ Technical/
Vocational ☐ Secondary/ Training College ☐ Tertiary ☐ Others specify ☐
6. Household size: i) 1-3 ☐ ii) 4-5 ☐ iii) 6-7 ☐ iv 8 and above.[☐].
7. Main occupation:.....Cash obtained:.....per year
8. Minor occupation:.....Cash obtained.....per year
9. Religion: Christianity ☐ Islam ☐ Traditional ☐
Others specify.....

INFORMATION ON FUEL WOOD USERS

1. How many meals do you cook a day?
One ☐ Two ☐ Three ☐ Others (Specify) ☐
2. What do you do to make your fuel last longer (cost less)?
.....
3. If given the options, which fuel would you use?
Charcoal ☐ firewood ☐ Kerosene ☐ Gas ☐ Electricity ☐
4. Why?
Easy to get ☐ Cheaper to use ☐ Safer to use ☐ Fast in cooking ☐
Neat to use ☐ Easy to start ☐
5. How did you get (buy) the firewood/charcoal the last time you had it?
Small ☐ Tin ☐ Basin ☐ Bag ☐ Headload ☐ Others (Specify)
6. Where did you get it?
Market ☐ Local/Neighboring Retailer ☐ Peddler ☐ Others (Specify)
.....
7. How far is the source from home?
8. What is your preferred tree species?
i.....ii).....iii).....
9. What is the average time spent to collect the firewood?
1-3hrs ☐ 4 - 6hrs ☐ 7 - 9hrs ☐ Full Day ☐
10. How often do you collect fuel wood?
Daily ☐ Twice Weekly ☐ Weekly ☐ Others (Specify)

11. How was the source five years ago?

.....

9. How much do you spend in a day on wood fuel?

i) 1000 cedis and below ii) 1000-2000 iii) 2000-5000 cedis

10. What is your approximate monthly expenditure on commonly used energy?

i) Charcoal,..... ii) Fire wood..... iii) Kerosene.....

iv) L P G..... v) electricity.....

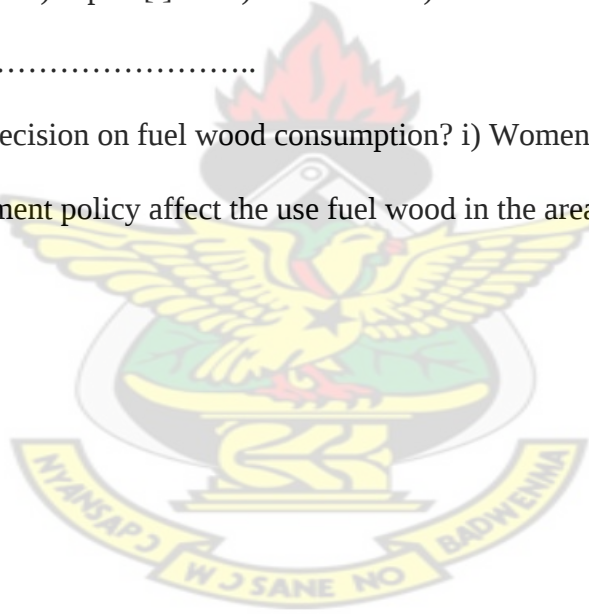
11. How do you burn your wood fuel?

i) Open fire ii) tripod [] iii) stove iv) others

Specify.....

12. Who makes decision on fuel wood consumption? i) Women [] ii) men []

13. What government policy affect the use fuel wood in the area?.....



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QUESTIONNAIRE FOR MSc. AGROFORESTRY THESIS

TOPIC:

SOCIO-ECONOMIC ANALYSIS OF FUELWOOD PRODUCTION AND
UTILIZATION IN THE UPPER DENKYIRA DISTRICT OF GHANA

TREE PLANTATION (WOOD LOT) PRODUCTION AND MANAGAMENT

PERSONAL DATA

1. Name of respondent.....
2. Age.....3. Sex: Male ☐ Female ☐
3. Marital status: Single ☐ Married ☐ Widow ☐
4. Educational level: Illiteracy ☐ Primary ☐ Middle/JSS ☐ Technical/
Vocational ☐ Secondary/ Training College ☐ Tertiary ☐ Others specify ☐
5. Household size: i) 1-3 ☐ ii) 4-6 ☐ iii) 7-10 ☐
6. Main occupation:.....Cash obtained:.....per year
7. Minor occupation:.....Cash obtained:.....per year
8. Religion: Christianity ☐ Islam ☐ Traditional ☐
- Others, specify.....

INFORMATION ON TREE PLANTATION (WOOD LOT)

PRODUCTION AND MANAGEMENT

1. What is size of your plantation? I) 1-2 [] ii) 3-5 [] iii) 6-10 [] others specify.....
2. Why do you plant trees?
i) For fuel wood [] ii) electric poles [] iii) timber [] iv) others []
Specify.....
3. What tree species do you plant?
i) Teak [] ii) others specify
4. Where do you procure your seedlings?.....
5. How do you acquire your land?
i) Family [] ii) leasehold [] iii) purchase [] iv) [] others
Specify.....
6. How do you harvest your trees?.....
7. Do you need permit before harvesting your trees?
i) Yes [] ii) no []
8. How long doe your trees take to mature for harvesting?
i) 5-10yrs[] ii) 10- 15yrs.[]
9. How do you harvest you trees?.....
10. Have started harvesting your trees?
i) Yes [] ii) no []

11. Is tree planting profitable?

i) Yes [] ii no []

12. Do you think tree plantation competes with food crop production?

i) Yes [] ii) No []

13. If yes can you explain?.....

14. How much do you get from your plantation in terms of income?.....

15. Is there any tax or incentives given to wood lot producers?

i) Yes [] ii) No []

If yes in what form?.....

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APPENDIX B

PLATES



Plate 1: Woodlot at Boa-Amposam Secondary School



Plate 2: Woodlot at Dunkwa Secondary Technical School



Plate 3: Pile of fire wood being split into smaller units for retail sale



Plate 4: Charcoal producer harvesting his charcoal



Plate 5: Researcher interviewing a charcoal producer at Dunkwa-On-Offin



Plate 6: Harvested charcoal ready for bagging



Plate 7: Women conveying charcoal to the market



Plate 8: An interview with the domestic Bursar at Dunkwa Government Hospital on the use of wood fuel