KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF RENEWABLE NATURAL RESOURCES

DEPARTMENT OF AGROFORESTRY

THE POTENTIAL OF AGROFORESTRY IN FUELWOOD PRODUCTION FOR DOMESTIC AND INCOME GENERATION ACTIVITIES – A CASE STUDY OF THREE COMMUNITIES IN THE SUNYANI DISTRICT OF THE BRONG AHAFO REGION GHANA.

BY

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BSc. (HONS)

JUNE 2011

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The Potential Of Agroforestry In Fuelwood Production For Domestic And Income Generation Activities – A Case Study Of Three Communities In The Sunyani District Of The Brong Ahafo Region Ghana.

A thesis submitted the School of Graduate Studies, Kwame Nkrumah University of Science and Technology in partial fulfillment of the requirements for the MASTER OF SCIENCE (Msc.) Degree in Agroforestry

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Science degree in Agroforestry and thus all references and quotations cited in support of the results and the concomitant arguments have been duly acknowledged.

……

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ACKNOWLEDGEMENTS

In the preparation of this work, I am heavily indebted to Prof. S.J. Quashie-Sam my supervisor who in spite of his heavy schedule furnished me with guidance, suggestions and constructive criticisms to carry out this work.

I would also want to thank the lecturers of the Agroforestry Department and the Faculty of Renewable Natural Resources for their constructive criticisms during lectures, seminar sessions and various formal and informal discussions especially Doctor Stephen Amissah of the Fisheries Department. I also appreciate fully the help, contributions and tactical suggestions of Dr. Evans L. Dawoe who stepped in at a critical point and worked at the speed of light to ensure I caught up with time.

I wish to express my heartfelt gratitude to all my mates and colleagues particularly Mr. Kweku Gyamfi for his constant encouragement and checks to ensure I was upbeat. I am also indebted to my siblings especially Joana and Ebo Amuah without whose moral, physical, financial and spiritual support I could not have come up with this important educative material.

Finally, my thanks and appreciations go to Mr. Mawuena Dzogbefia, Madam Harriet Takyi and Mark Kopecky who although not in my field always kept an eye on me from the miles to ensure I did go every lap of the journey. They served as the eagle eye watching to ensure my focus got back on track whenever it swayed with the pressure of demands on my energy within the season of the study. God bless you all richly.

DEDICATION

This work is dedicated to my mum Madam Harriet Efua Ampa-Korsah who has always believed in me and urged me to push to my limits. It is equally dedicated to the late Prof. Kwesi Kwansah Andam whose voice resounds in my ears every time I am at the verge of giving up saying – "bitter the chastening rod felt in the days when hope unborn had died… Yet with a steady beat have not our weary feat come to the days for which our fathers sighed." Me da ase. Ayekoo!

ABSTRACT

Fuelwood is used for cooking and heating by a greater proportion of the ever increasing Ghanaian population. Firewood gathering and sale coupled with fuel-based income generating activities are very important livelihoods in forest fringe communities especially the forest transition zones in Brong Ahafo region that produce most of the fuelwood. However, the dwindling of such tree resources implies that alternative means of providing fuelwood needs need to be pursued to improve the situation and reduce the risk and vulnerability of farmers' livelihood. The study was conducted to assess fuelwood production and supply as a potentially viable and sustainable cash income generation activity in three forest fringe communities of the Sunyani district. Specifically, it examines the main sources accessed and the forms of fuelwood used, describes the fuelwood consumption, preferences and how it impacts the fuelwood trading enterprise. It also examines the constraints of accessing available fuelwood, the awareness of agroforestry and its potential on the adoption of agroforestry for fuelwood production towards improved livelihoods. Random and purposive sampling techniques were used to collect data using semi structured questionnaire and focus group discussions. Data was analyzed using SPSS version 15.0 and Microsoft Excel. The findings show that most households in the study communities (79% of respondents) purchase most of their fuelwood; especially in Fiapre, where charcoal is consumed the most, with preferred species supplied from Wenchi, Kintampo and New Longoro districts. Respondents spent an average of GHc 1.22 on domestic fuelwood weekly. Fuel based income generation activities are constrained due to dwindling fuelwood supplies. The most preferred species of fuelwood were identified as *Celtis zenkeri and Magaritaria discoidea* whereas charcoal burners preferred *Anogeissus leiocarpus* and *Senna siamea*. Charcoal producers in Sunyani are not able to meet the local fuelwood demand and do not plant trees. Sawmill off cuts and dead teak pruning

were frequently resorted to in time of shortages. Most respondents (67%) were found to have a fair knowledge of agroforestry and identified teak as a must have if planting trees to meet cash needs. High transportation cost was found to contribute to the rising cost of charcoal. Respondents were willing to adopt some agroforestry technologies to enhance fuelwood supply. Fragmentation of landholding, tenure constraints, slow growth and coppicing re-growth rate of tree species, and lack of requisite knowledge were identified as factors inhibiting the adoption of agroforestry technologies. The study concludes that though forest fringe communities may have access to free fuelwood, they are extremely constrained despite available forest resources and thus purchase fuelwood. It recommends that agroforestry technologies such as fast growing rotational woodlots, home gardens and live fences are adopted by households and farmers to help improve fuelwood supply and livelihoods.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Ghana's rural population is said to be 70 percent of the total country's population. With a current population of 24.5million and an annual growth rate of 2.6percent Ghana's population will double to around 33 million in the year 2020 (Ghana Statistical Service, 2010). About 32 percent of Ghana's population lives below the poverty line. For many of the poor particularly those in rural communities and living adjacent to forests, forest resources including fuelwood directly or indirectly contribute to sustaining their livelihoods (Byron and Arnold, 1999).

Agriculture, including forestry, is the backbone of the Ghanaian economy. It provides 43 percent of the Gross Domestic Product, 50 percent of export earnings and 70 percent of total employment. Forestry as a sub-sector accounts for 6 percent of the GDP, 11 percent of export earnings and employs a labour force of 100,000 people (Forestry Outlook Study for Africa, 2003). Income earned in such rural areas is low since these people depend on agricultural proceeds.

Many rural people are also engaged in some income generation activities to supplement their incomes. To continue supporting the rural poor to move them out of poverty, it is important to increase agricultural productivity, especially for small and medium sized farmers, and facilitate their diversification into other rural non - farm activities. (World Bank, 2005a). Escaping poverty is also harder for women, due to

gender inequalities from the household to the market, which reduce their range of income-earning options and the returns to their labour and education (Kabeer, 1995).

Productive uses of energy are important to economic growth such as in agroprocessing activities in the informal sector. In Ghana, it is reliably estimated that 14 million m^3 of wood are consumed for energy production. It has also been estimated that the volume of fuel wood consumption in Ghana could rise to 20 million m^3 by the year 2010. Energy services and rural income generating activity such as charcoal production is concentrated in the transition zones (between the forest and the savanna woodlands). Most of the wood comes from savanna trees, which are felled for this purpose, and also from logging residues. It is being estimated that of the total round wood production in Ghana, 91 percent is used as firewood and charcoal. The remaining (9 percent) is used as industrial round wood (Forestry Outlook Study for Africa, 2003).

1.2 Problem Statement and justification for the study.

Fuelwood is still widely used among all classes of people across sub Saharan Africa. The fact that charcoal consumption is dominated by urban users fuels the accusation that rural users subsidize and bear the brunt of urban energy use, as the supplies taken from rural areas directly affects local availability of woodfuels. The rural woodfuel users are adversely affected through increasing amounts of time spent collecting woodfuels and through cutting of forests and destruction of an ecosystem that may indirectly affect them via increased erosion, soil fertility loss or loss of animal habitat (Karenzi, 1994).

The high price of alternative energy sources, such as gas, oil and electricity, and their uncertain supply encourages use of fuelwood to these sources. The depletion of the woodlands combined with the persistent dependency on fuelwood will eventually pose a serious problem for household energy provision (Brouwer, 1997). Although unit cost of energy due to inefficiencies while using fuelwood is high, to switch to other fuels, rural people must be able to afford and supplies must be reliable. Rural cash incomes are generally very low. As such more opportunities need to be identified and exploited for cash incomes. With the steadily growing population, the fuelwood business is an area of potential for cash incomes from planned cultivation and management of trees and natural resources (IFAD, 2001). Further, persistence of such fuelwood problems could stifle some aspects of the income generation efforts of many rural people who need to depend largely on available raw materials within and around their environs to survive.

The communities in question are poor forest fringe communities and depend to some extent on the Tain II for their fuelwood needs and to sustaining their livelihoods. But there are the challenges of depending on this reserved forest. It is important to find more sustainable means of ensuring fuelwood availability to ease the pressure on the residents and possibly the natural resource (Tain II). Agroforestry (AGF) technologies can improve the situation and help meet these challenges. Although AGF is a potential source of extra income and energy supply, it is necessary to examine the awareness of AGF among the people. An examination of how their attitudes and socio economic status affect the adoption of AGF technologies that fit into their predominantly subsistence agriculture is important. This will help improve cash incomes and fuelwood availability for domestic purposes and energy dependent

income generation activities. It is therefore the aim of this study to evaluate fuelwood production and its supply chain as a viable and sustainable cash income generation activity through adoption of AGF technologies in the rural communities.

1.3 Relevance of Study

The study seeks to lay the groundwork for the extension of AGF practices that could satisfy the fuelwood and socio economic needs of people in the study area with special reference to those engaged in income generating activities that demand regular fuelwood use. It is also important to explore and identify the various sources of the fuelwood supplied. Information regarding deficits and shortages if any and how they cope with these constraints will be important to help identify potential sources of fuelwood.

Women are mostly responsible for many management activities on the farms and cater for basic household needs such as food, fuelwood and water which are already in insufficient supplies. Gathering and collecting fuelwood alongside their farming activities involve walking long distances. Decreasing supplies of fuelwood have adverse effects on women (Sesabo and Tol, 2005).

The eight Millennium Development Goals (MDGs) do not include any specific energy target but energy is linked to and affects the achievement of every single one of them especially economic growth, eradication of extreme hunger and poverty, ensuring environmental sustainability and promoting gender equality and the empowerment of women. There is persistent poverty in the rural areas of developing countries like Ghana. Therefore it is important and there is urgent need to create a

sustainable and affordable production and supply of fuelwood for the rural poor within their localities to meet their cooking and heating needs.

1.4 General Objective

This study has a general objective of evaluating fuelwood production and supply chain as a potentially viable and sustainable cash income generation activity in the study area.

1.4.1 Specific Objectives

The specific objectives of the study are to:

a. Identify the sources of fuelwood for domestic purposes and other fuel based income generation activities in the district.

b. Assess fuelwood consumption patterns as income generation activities and its impact on the fuelwood trading enterprise.

c. Determine respondents' level of knowledge and awareness of agroforestry and the potential for its adoption for an improved livelihood, through fuelwood production.

d. Identify the constraints and challenges of accessing fuelwood species and adopting agroforestry for fuelwood production for meeting energy needs.

1.5 Research Questions

The questions that guided the study were:

i. What is the distribution of the main forms of cooking energy utilized?

ii. What are the sources of fuelwood consumed?

iii. What are the alternative sources of fuelwood supplied/consumed?

iv. What are the fuel based income generating activities in the study area?

v. What factors influence to the choice of fuelwood consumed?

vi. What are the quantities and cost of fuelwood used in homes?

vii. What technologies exist for firewood and charcoal production?

viii. What type of tree species are preferred for fuelwood supply and use and why?

ix. What are the constraints to accessing fuelwood?

x. What are the constraints of accessing/supplying preferred tree species for fuel?

xi. What is the level of awareness of agroforestry among respondents?

xii. What are the perceived benefits of trees within the area?

xiii. What knowledge of trees and tree management practices exist among the people?

xiv. What is the likelihood of adopting agroforestry in the communities?

xv. What are the constraints of adopting agroforestry?

xvi. How can AGF help improve cash income generation?

1.6 Scope of the Study

The study focuses on the nature of availability, supply, utilization and production of fuelwood needed for domestic and income generation activities in the Sunyani District of the Brong Ahafo Region of Ghana. A total of three forest fringe communities were surveyed within the Sunyani district around Tain II forest reserve.

It is the target of the study to identify gaps and hence opportunities in the fuelwood supply business. It also intends to explore the degree to which the communities are

aware of agroforestry practices in land use systems and the possibility of adoption of agroforestry technologies to contribute to the supply of local fuelwood needs and possible income generation to improve livelihoods.

The constraints and challenges of the availability of fuelwood in the three communities and the fuelwood supply chain locally and outside Sunyani District were also examined.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Poverty and Forestry in Rural Development

More than 1.2 billion people (that is one in every five people) live in extreme poverty (IFAD, 2001). Poverty is a deprivation of essential assets and opportunities to which every human being is entitled. Clearly, one can think of poverty from a non-monetary perspective. Although widely used, monetary poverty is not the exclusive paradigm for poverty measurement and non-monetary dimensions of poverty are useful in assessing poverty components. It is a general phenomenon that the poor are found in the rural areas. This is often considered to be true because they hardly earn cash (Ellis, 1998). In most poor countries including Ghana, agriculture is the largest employer and export earner. Most of the poorest countries in the world are found in Africa and Central and Southern Asia, although they are dotted throughout Latin America, Eastern Europe, and the Middle East, as well. Nearly all are dependent on agriculture for major source of income and sustenance among the rural populations. Most rural people in these countries remain in poverty because agriculture has not grown fast enough to keep up with population growth and non-farm employment opportunities are lacking (World Bank, 2003). The causes for "extreme consumption poverty" among people who live and work in rural areas are numerous. Factors related to the environment and natural context include: the scarcity of natural resources (especially water and soil) and the sheer technical difficulties in using these in a sustainable way; the remoteness of farms and poor means of communication and transport; as well as the harsh climate and frequency of natural disasters (Heierli and Gass, 2001).

Forests in many developing countries were originally established for export purposes and hence as a foreign exchange earner and hardly had the needs of the rural dweller in focus. There have been substantial incomes but these were never directly accrued in any manner to the rural dweller. The harvesting of tropical forests for timber and secondary products whether for export or internal consumption such as wood based biomass energy can be an important element in strategies for rural development. We must employ schemes for the sustainable management of resources, however or the benefits will be short lived and serious ecological and social consequences will result (Bentley and Gowen, 1994).

2.1.1 Women and Poverty

Over 70 percent of Ghana's poor are self-employed and poverty among food crop farmers represents more than 50percent of total poverty in Ghana. Women, children and youth are especially vulnerable. High rates of inflation, low private savings and investments and inadequate access to basic amenities still persist (Canadian International Development Agency, 1999). Labour markets remain highly discriminatory and women often get trapped in low-wage forms of work (Heyzer and Sen, 1994). Accurate data on poverty is not available even though some studies suggest that its incidence among rural women and female-headed households is higher than average. Women's access to credit is restricted by the unavailability of land title as collateral. There is general agreement that gender plays an important role in deciding how household income is dispensed. Women tend to spend more of their income on food, education and health. As traditionally women's loan repayment rate is higher than men's, donor agencies and NGOs have actively pursued female clients.

Group lending has become a common venue for extending credit in both rural and urban areas - especially to women (UN, 2001).

2.2 Forestry and agriculture as rural income generation activities

The combination of assets and activities from which rural dwellers earn a living is often referred to as the household's livelihood strategy. A livelihood strategy encompasses not only activities that generate income, but many other kinds of choices, including cultural and social choices, that come together to make up the primary occupation of a household (Ellis, 1998**).**

Most rural dwellers often have alternative livelihood strategies depending on the resources existing within their communities. In a report on Ghana, major alternative livelihood activities were grouped into three main categories, namely forest-based livelihoods, forest-related livelihoods and other 'footloose' activities that may not be related to the forest at all. While potential forest-based income generating activities include taungya schemes, rattan and bamboo collection, medicinal plants gathering, establishment of woodlot/nurseries, and forest enrichment planting (Tropenbos International, 2005), most rural dwellers have failed to take full advantage of these livelihood strategies. It is imperative that, to reduce poverty levels and status of women, rural dwellers need to diversify into other activities particularly those with the potential of reducing rural energy shortfalls.

2.2.1 Rural diversification challenges and constraints

Rural dwellers often times need to diversify in their income earning activities since cropping and animal husbandry do not readily provide income all year round. Very

often, the marginalization concerns entire regions and populations, not only the farming community. The non-farm sector (trade, crafts, industry and services) is an important factor for employment, but it usually depends on a flourishing farm sector. Where there is no dynamic and prosperous farming activity, there is usually also little non-farm activity. Nevertheless, a flourishing farming sector depends on thriving markets, and these markets may be urban markets, agro-based industrial production centres or export markets. Whereas an industrial enterprise increases its productivity through specialization and economies of scale, a household enterprise optimizes its income through diversification of their income sources; they complement their incomes through additional activities (having a job plus a garden and small animals (Heierli and Gass, 2001).

Several forces influence the households' decision to participate in different activities. Evidence suggests that the decision to participate in a certain activity is triggered by the rewards offered, risks associated with the activity and households' capacity, which is determined by the assets endowment and this explains why not all households have the same opportunities to participate in different activities (Sesabo and Tol, 2005). By providing material capital to a poor person, their sense of dignity is strengthened and this can help to empower the person to participate in the economy and society (Otero, 1999). Many people especially in the rural areas of Ghana still live below the poverty line. A lot more earn far less than GH¢ 2.25 a day which is the daily minimum wage in Ghana. A number of institutions are involved in numerous approaches to help alleviate poverty through micro credit in Ghana.

The challenge of markets and related issues affect rural income generation efforts. Market orientated agriculture for reducing poverty and environmental degradation needs to centre on three related paradigms; strengthening biological processes in agriculture (to optimize nutrient cycling, minimize external inputs and maximize the efficiency of their use); building farmer's capacities (to learn and innovate focused on improving livelihoods and the management of natural resources); and developing forward and backward linkages (between natural resources, production and markets **(**Sesabo and Tol, 2005**).**

2.3 Fuelwood and deforestation

The total land area of Ghana had 34percent originally rainforest coverage. Today very little is covered by forest. Since the colonial era, the exploitation of timber for commercial purposes has been part of Ghana economy. It is only since the start of the Economic Reforms Programme (ERP) in 1983 that deforestation has become a serious concern because of the over-exploitation of the forest resources. Forest resources in Ghana are being depleted at a faster rate than before compared to other developing countries. Since 1981, the average annual rate of deforestation in Ghana is estimated at 2.0percent compared to 0.9percent for all tropical forest, 0.6percent for Zaire, and 0.6percent for Brazil (WRI, 1990). In Ghana, efforts by government to reduce deforestation have yielded limited success, primarily because many of the initiatives were misguided and /or failed to deal with deforestation as a complex, dynamic and interwoven process (Marfo, 2010).

2.3.1 Drivers of desertification and deforestation in Ghana

In Ghana, land area prone to desertification and the extent is seen in Table 2.1. There are several causes of deforestation and desertification including, bushfires, illegal chainsaw logging, extraction of woodfuel for charcoal production etc. **C**harcoal production especially has a tendency to continue and put persistent pressure on the limited land. In the savanna, desertification is seen to be stretched over vast land. This is due to the preferred tree species for charcoal produced and supplied to both rural and urban areas (EPA, 2005). This puts pressure on the tree resources in the savanna woodland.

Table 2.1 Desertification in Ghana

Description	Area(km^2)	Percentage
Low	17,000	7.47
Moderate	112,000	48.78
High	34,000	15.15
Very high	2000	1.04
Total	165,000	100

Source: EPA, 2005

Bushfire destroys between 6 and 14 million hectares of forest, about half in tropics. In Ghana it is recurrent and it history complex. Oral and documented records of burning can be used to reconstruct the increasing effects of recurrent fires on forest structure and composition (UNEP, 2007). The semi deciduous forest of Ghana and savanna are depleting mainly in Ashanti and Brong Ahafo regions leading to tree extinction. The dominant trees are *Celtic triplochiton, Antiaris chlorophora, Celtic milbraedii, Triplochiton scleroxylon, Antiaris africana* and *Chlorophora excelsa.* A mixture of

semi deciduous and savanna vegetation such as includes species *Daniella oliveri*, *Terminalia macroptera* and *Borassus aethiopum* of which many have vanished (Forestry Research Institute of Ghana, 2003).

2.4 Household energy sector and energy consumption in Ghana

Energy security is related to development. According to Gordon *et al.* (2004), energy resources are not evenly distributed across the world nor are their different usages all environmentally maligned. Energy as an important engine for economic growth continues to be a challenge in developing countries especially where percentage distribution of households using biomass fuels exceeding 80 percent is dominant in Africa (Figure 2.1). Increasing prices of fossil fuels continues to be an issue of concern. While there is no Millennium Development

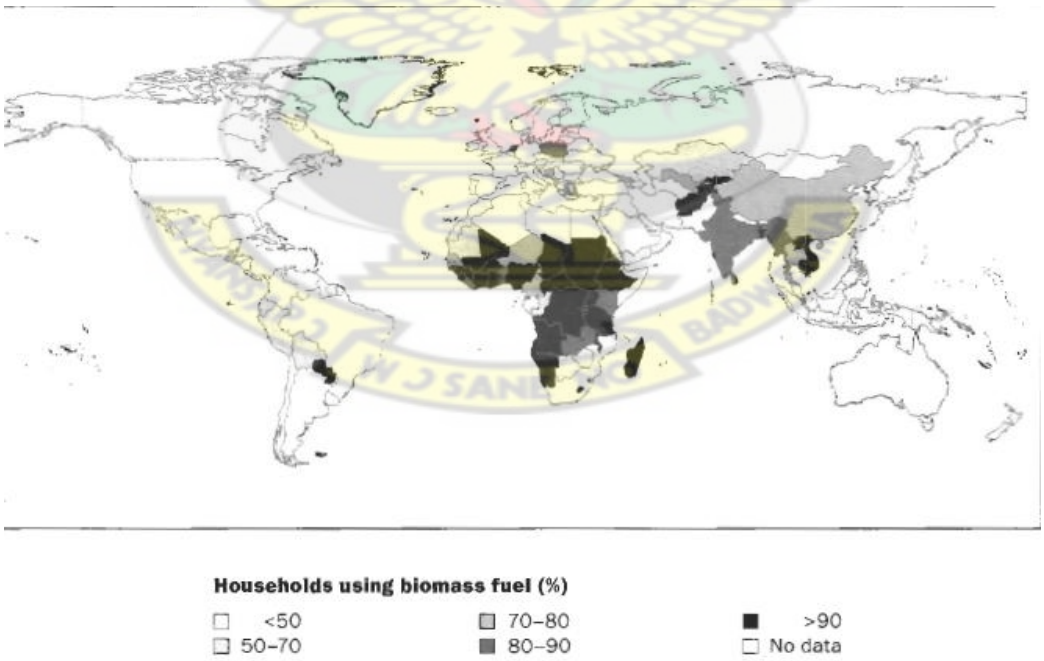


Figure 2.1 Percentage households using biomass fuels worldwide
Source: Gordon *et al.*, 2004

Goal (MDG) specifically on energy, access to energy services is a prerequisite to the achievement of all eight MDGs. This was realized at the World Summit for Sustainable Development (WSSD) in Johannesburg in 2002 (UNDP, 2005). Apparently, much greater quantities and much greater quality of energy services will be required to meet these MDGS than are presently available in developing countries. Access to needed energy services is an important tool in helping promote economic growth, social equality, and environmental sustainability (IEA, 1998). It is at least important to ensure that rural households have access and can afford the domestic cooking and heating energy.

The household sector alone accounted for 52 percent of the total energy consumption in Ghana for the year 2000. Household energy consumption is primary for cooking and lighting. Fuelwood is used in the forms of firewood and charcoal in many places for reasons of availability and affordability. About 69 percent of all urban households in Ghana use charcoal for cooking and heating and the annual per capita consumption is around 180 kg. The total annual consumption is about 700,000 tons, 30percent of which is consumed in the capital, Accra (Ministry of Energy, 2002). It is reliably estimated that 14 million m^3 of wood is consumed in Ghana, for energy production. It has also been estimated that the volume of fuel wood consumed in Ghana could rise to 20 million m^3 by the year 2010 (Ghanaian Chronicle, 2006).

Projections of energy consumption in Ghana (Table 2.2) indicate a steady rise which is only natural due to a steadily increasing population. Although the growth rate of the use of Liquefied Petroleum Gas (LPG) is the highest (Ministry of Energy, 2002),

there is a greater amount of biomass fuels being consumed in the forms of charcoal and firewood.

Table 2.2 Projections of fuel consumption (‘000 tonnes) 1995-2000

Fuel	1990	1995	2000	Annual Growth Rate %
LPG	6	11.55	22.24	14.0
Kerosene	167	168.68	170.37	0.6
Charcoal	637	812.99	1,037.61	5.0
Fuelwood	7,019	7,941.35	6,984.91	2.5

Source: Adapted from Ampadu-Agyei *et al.* (1994)

Charcoal is especially important since it demands greater volumes of wood to produce charcoal irrespective of the dwindling supplies from forest resources of Ghana (EPA, 2005). Also, it is believed that the use of fuelwood for domestic purposes will hardly fizzle out in most developing countries. It has been estimated that approximately half the global population and up to 90 percent of rural households in developing countries still rely on biomass fuels (WRI, 1999). Considering the fact that 70percent of the total national energy consumption is accounted for by biomass in either the direct or processed form (KITE, 1999), the big question that remains to be answered is whether Ghana’s dwindling forest resources can sustain the increasing demand for fuelwood? Firewood and charcoal alone accounts for more than 93 percent of energy used for cooking (Figure 2.2).

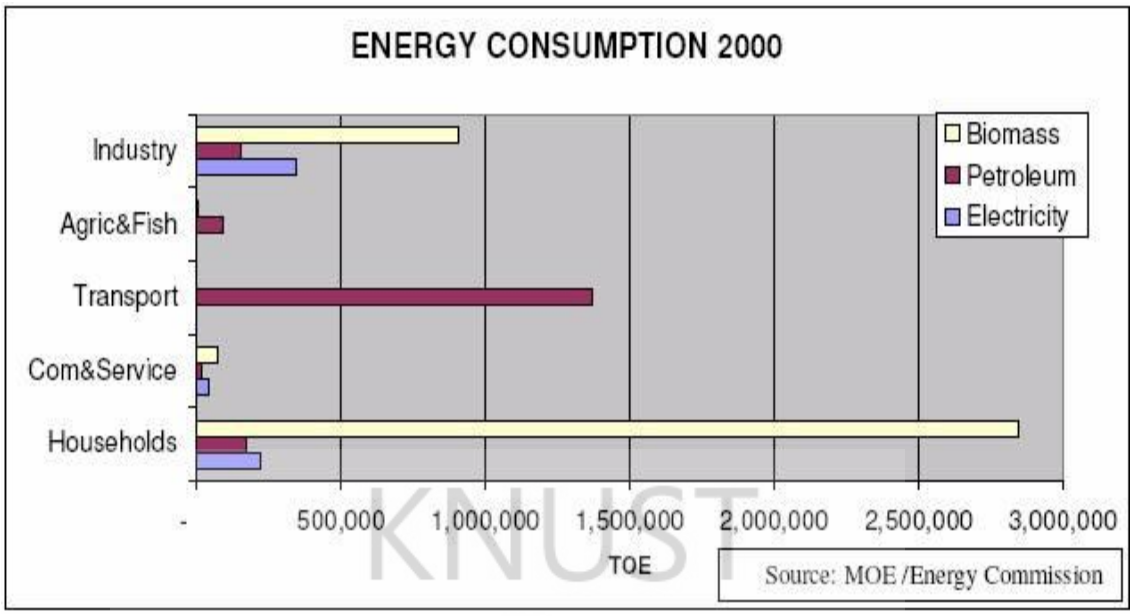


Figure 2.2: Energy consumption in Ghana (2000)
Source: Ministry of Energy, 2002.

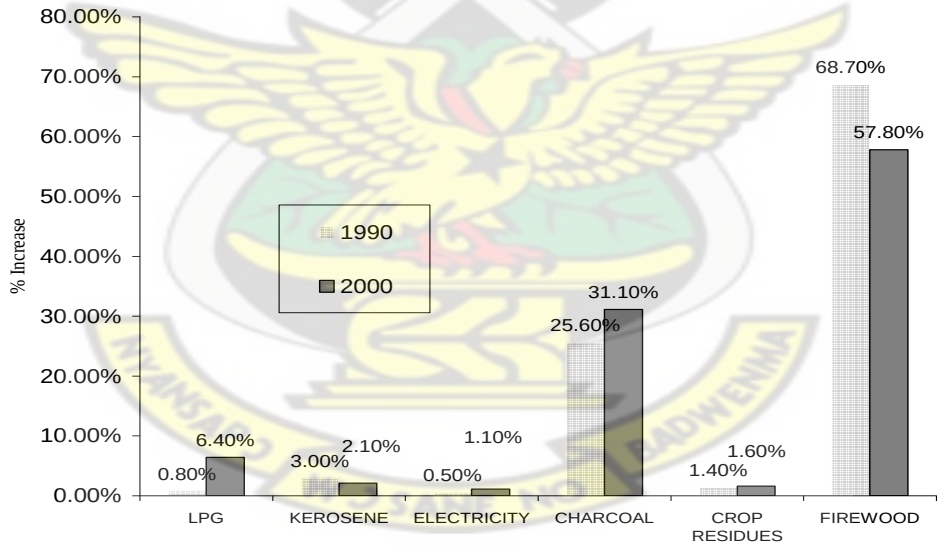


Fig 2.3: Percentage main household cooking energy trend in Ghana
Source: Adapted from Ahiataku-Togobo, 2007

It is also worth mentioning that 67 percent (24,890 GWh/yr) of total energy consumption in the household is for cooking. LPG, kerosene and electricity use though cleaner, accounts less (Figure 2.3). Despite efforts to ensure access to modern

cooking fuel, the effect has been negligible. Over 90 percent of households in Ghana still use fuelwood (Ahiataku-Togobo, 2007).

2.5 Charcoal production, demand and commercialization

Forest loss is due to a lot of pressure on land for several uses of which charcoal production for domestic energy uses is one. A detailed UNDP/WB study predicted in the mid-1990's that lands would become scarcer and charcoal producers would turn to other sources to obtain wood. A lack of alternative sources of wood, i.e., plantations or farmland, would result in large-scale land clearing for the purpose of providing wood for charcoal. Already, clearing of forests in Kenya is beginning to subside due to decreasing potential land. If the demand for charcoal does not simultaneously subside, then other areas will have to be exploited. Otherwise, charcoal prices will rise. Transport issues seem to play a larger role as the woodfuel source for charcoal production becomes scarcer near urban areas of charcoal demand. Finally, from a global warming perspective, charcoal use is among the worst, if not *the* worst, cooking energy source, and substitution or new production methods may be advisable (World Energy Assessment, 2000). This is the point where sawmill waste production of charcoal using the Kiln method may be one of the better and perhaps wise option to exploit for fuelwood in these timber producing and processing districts of the Brong Ahafo Region.

Though charcoal may be produced from wood obtained from plantations, it is more likely to be produced from land cleared for agricultural purposes or from smaller areas cleared specifically for charcoal production. In many countries, the rural people and even charcoal producers are too poor to use charcoal, and the demand for

charcoal is found in the urban areas. This often means that the charcoal is produced far from the demand points and must be transported, typically via truck, to the user. As the fuelwood supply and potential agricultural land supply dwindles, transport distances may approach 1000 km. Easily accessible fuelwood is then also co-opted for the urban dwellers, leaving rural areas with fewer accessible biomass supplies (Kammen and Lew, 2005).

Ghana is likely to consume more than 25 million tonnes of fuel wood by the year 2020 (EPA, 2005). The savanna and forest-savanna transition zones of the Ashanti and Brong Ahafo Regions are major producing areas for the commercial charcoal trade which supplies Ghana's major urban centres. Different social actors engage in these woodfuel-related activities in different ways. Charcoal production for commercial sale is dominated by the immigrant *Sissala* group. Individuals belonging to the stool families and other large landowners often engage in large-scale charcoal production, hiring the labour of so-called professional charcoal burners. Tobacco farmers also make use of large amounts of fuelwood in curing tobacco leaves. (Afikorah - Danquah, 1996)

Contrary to developed countries which utilize up to 95 percent of the harvested wood, only about 15percent of each tree cut in Ghana is used commercially. A major part of the tree is left to rot after taking the trunk for export. For many people in rural areas today, fuelwood gathering and collection of such residues of wood is an income generating activity. This is due to dwindling fuelwood supplies within the country. In spite of the gravity of environmental hazards associated with charcoal burning in the country, it is ranking first on the scale of Internally Generated Fund (IGF) to the

newly created Tain district in the Brong Ahafo Region. Disclosing this, a source at the district finance office told the Ghanaian Chronicle (2006) that about 60 percent of the District's internally generated funds depend on revenue generated from taxes from the charcoal transactions.

2.6 Fuelwood consumption and costs

On the household side, there are a couple of reasons to believe that rural people will be more adversely affected than their urban counterparts. Food, housing, and transportation account for about 75 percent of the energy consumption of a typical rural household. The proportion of a family's budget spent for energy (direct and indirect) is inversely related to level of income. Since low-income families assign a significantly larger share of their income to these items, their dependence on energy is relatively greater. An increase in the cost of energy therefore has a relatively greater impact on lower-income families (Abakah, 1990). Since rural incomes are somewhat lower than urban incomes, the effect on the rural population is proportionately greater.

At the local level, the impact of fuelwood demand takes on special significance. In a town in central Sudan, for example, 38 percent of all fuelwood is used by bakeries, restaurants, schools, and the local prison and hospital. In Ouagadougou the making of traditional millet beer alone consumes 15 percent of that city's daily wood supply. A brick-making plant in Niger is reported to require 30 steres of wood every day, roughly equivalent to the domestic energy needs of 6000 people. In tobacco-growing regions, the curing of tobacco leaves consumes an extraordinary amount of wood. In Tanzania it is estimated that an entire hectare of woodland is used to cure one hectare

of tobacco, or 1 stacked cubic meter of wood for every 7.5 kg of tobacco leaf (FAO, 2007).

A clear illustration of the poor in developing countries paying far higher prices per unit of energy with urban counterparts better off is seen in research in Beira Mozambique household where the use of charcoal for cooking and kerosene for lighting costs about US $ 5 and US $2.10 respectively a month. This is expensive when wages of the female head-of-household is less than $30 implying 27 percent incomes for energy as compared to United Kingdom average household spending on energy which is 4 percent (FAO, 1993).

2.7 Factors that influence cooking fuel choices

Charcoal and firewood are distinct fuels, each with its own market and applications. Unlike firewood, charcoal is always produced, transported, and sold commercially. People do not forage for charcoal as they might for wood nor is charcoal likely to be widely used where firewood can be readily obtained free of charge. As a consumer good, charcoal competes with other commercially available fuels, such as kerosene, propane gas, electricity, and marketed fuelwood. Thus the domestic consumption of charcoal depends largely on its price relative to these (Wood and Baldwin, 1985). In the case of Ghana, it is no different as Figure 2.4 shows that prices in the study show a relatively stable prices trend for fuelwood as compared to electricity, kerosene and LPG whose supply and pricing is rather erratic.

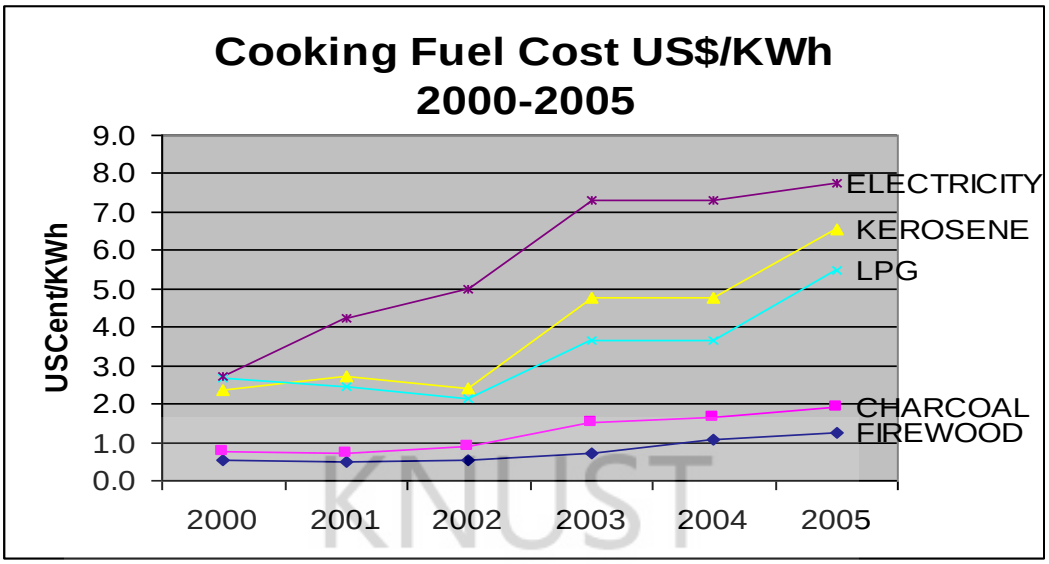


Figure 2.4 Cost of cooking energy in Ghana.

Source: Ahiataku-Togobo, 2007

Already, biomass users prefer charcoal over other biomass fuels such as wood residues and dung for various reasons. This is because charcoal has a higher energy density than other biomass fuels and can be stored without fear of insect problems. It has excellent cooking properties. It burns evenly for a long time and can be easily extinguished and reheated (Kammen and Lew, 2005).

However, price is not the only, or even the major factor of consideration in household fuel choices. Fuelwood which is near the bottom of the cooking energy ladder due to inconvenience and smoke is not necessarily the cheapest of energy options. In many cases, the availability of fuel supplies determines preferences. Additionally, even in cases where petroleum fuels are used, charcoal is often used as a backup fuel or the main fuel for preparation of certain foods. In Senegal, where LPG use is increasing, households using LPG are still using as much or more charcoal than households which only use charcoal (Ribot, 1993).

2.8 Agroforestry and fuelwood production

The International Energy Agency (IEA) estimated that the number of people using fuelwood and other biomass fuels in Africa will rise by more than 40 percent between 2000 and 2030 to about 700 million (IEA, 2002). Many regions in Africa are presently facing severe shortages of fuel wood, fodder and food primarily due to increasing human and livestock populations and crop production using little or no external inputs (FAO, 2003). Farmers resort to using marginal and erosion-prone soils and to encroaching upon forests for fuelwood (Nyirenda *et al*. 2001).

Persistent increase in deficits of fuelwood presents the challenge of seeking more sustainable means of providing regular energy for domestic and income generation activities. Forests and woodlands occupy an estimated 650 million ha or 21.8 per cent of the land area in Africa. These account for 16.8 per cent of the global forest cover (FAO 2005). In Uganda, for example, forests and woodlands are now recognized as an important component of the nation's stock of economic assets and they contribute in excess of US$546.6 million to the economy through forestry, tourism, agriculture and energy (Emerton and Muramira, 1999).

Over the last two decades, the promotion of woodlots for instance has become popular among the development agencies in Africa as a means of improving fuelwood supply to rural communities and generating income for households. Growing trees as woodlots on farms in rotation with crops is considered a potential technology to overcome the shortage of wood, which is a common problem to many parts of Uganda (Jacovelli and Caevalho, 1999). Not only would woodlots provide fuelwood and construction materials for domestic consumption, but they also serve as a source

of household income to supplement declining revenues from food crop sales. Additionally, growing trees and shrubs can reverse damage to soils and help to restore degraded lands (Stockholm Environmental Institute, 2007).

2.9 The role of Non Governmental Organisations in Agroforestry

Several NGOs have played crucial and important roles in promoting fuelwood production utilizing several modern agroforestry technologies in Ghana. One such example is the case of the Adventist Development and Relief Agency (ADRA) which has established 152 sustainable production AGF systems throughout the country including planting of trees such as *Tectonia grandis*, *Senna siamea, Albizia spp, Leucaena leucocephala, Mangifera indica, Azadiracta indica, Anacardium occidentali* and P*sidium guajava*. (Council for Scientific and Industrial Research, 2007)

From the year 1989, ADRA introduced wood lot establishment among other agroforestry systems in the two savanna zones of Ghana. *Senna siamea*, *Tectonia grandis*, *Azadiracta indica*, *Leucaena leucocephala*, *Eucalyptus spp* and *Albizia lebbeck* have been the most preferred species. In the Central region of Ghana for instance, wood lots established with *Senna siamea* have become the main source of charcoal production (Council for Scientific and Industrial Research, 2007).

With per capita fuelwood consumption in Ghana estimated to be 1.3 kg per person per day, woodlot establishment projects need to be facilitated in several rural areas of Ghana in different dimensions to help the movement towards a sustainable and affordable fuelwood industry. This is necessary because some agro-processing activities such as fish smoking, *gari* processing, *kenkey* making, bread baking and

many others are dominant employment avenues especially in the Brong Ahafo Region and are entirely dependent on firewood. The region is generally noted for its export oriented cashew cultivated on crop lands as the dominant agroforestry practice which helps them meet income and fuelwood needs (Djarbeng and Ameyaw, no date).

The success rate achieved by NGOs has been encouraging since they adopt a broader approach, which focuses on agro-diversity conservation through participatory, farmer-led approaches with help from experts. However, the success stories are limited to isolated areas in the country and to only few farmers associated with the various projects. This could be attributed to limited co-ordination and lack of synchrony between projects and also lack of effective links between research and development. (Asare, 2004). In several African countries including Kenya, Uganda, Gambia, Tanzania, Ghana and South Africa, the activities of several NGOs with local and donor aided tree planting works to help boost tree cover, thus improving fuelwood supply through the introduction of agroforestry practices (UNEP, 2001).

Reports of effort in Ghana at Wugulugu, a community in the Upper West region, between 2000 and 2003 show a community project releasing part of its relic forest having identified eight woodland reserves and established a total of 70 ha of woodlots using indigenous species to rehabilitate degraded woodlands and provided alternative sources of fuelwood and income for the communities. These woodlots were planted on communal lands donated by the *Tindana*, the spiritual landowner (Blay *et al.*, 2004).

Several factors trigger tree planting even at the local level. Two basic reasons for the need increase fuelwood production on a local level especially in many tropical regions have been identified. First, there is an acute scarcity of this form of daily needed energy. Secondly, globally, there is the need for a reduction of CO_2 emissions due to the global warming problem. Despite these facts, it is often very difficult to get more trees on the ground (Kürsten, 2008). However, fuelwood continues to prove to be a profitable and regularly demanded market commodity and attracts studies towards its efficient production. This is evident in Table 2.3 which indicates the quantities of fuelwood produced in several locations.

Table 2.3 Potential harvestable fuelwood produced by tree species planted in different AGF based land use practices in South African countries.

Agroforestry Practice	Country	Site	Tree species	Age of tree	Fuelwood quantity t/ha/yr
Countour strips	Tanzania	Lushoto	*Calliandra spp*	4.5	3.2
		Lushoto	*Casuarinas spp*	4.5	1.8
		Lushoto	*Croton spp*	4.5	1.5
		Lushoto	*Grevillea spp*	4.5	2.7
Woodlots	Tanzania	Mganga	*Acacia crassicarpa*	5	22.4
		Kiwango	*Acacia crassicarpa*	4	24.0
		Dotto	*Acacia crassicarpa*	4	19.5
		Sanania	*Acacia crassicarpa*	4	21.0
		Shinyanga	*Acacia nilotica*	7	1.2
		Shinyanga	*Acacia polycantha*	7	10.2
		Shinyanga	*Leucaena spp*	7	12.7
		Morogoro	*Acacia.Crassicarpa*	5	51.0
		Morogoro	*Acacia mangium*	5	40.0
		Morogoro	*Acacia polycantha*	5	39
		Morogoro	*Acacia nilotica*	5	27
		Morogoro	*Gliricida sepium*	5	30.0
Coppicing fallows	Zambia	Chipata	*Senna siamea*	3	10.7
		Chipata	*Leucaena spp*	3	9.7
		Chipata	*Sesbania sesban*	3	8
		Chipata	*Gliricida sepium*	1-3	7
Non-coppicing	Zambia	Chipata	*Sesbania sesban*	7.3	7.3

Adapted from Sileshi, 2007.

2.10 Economic Incentives for fuel based agroforestry adoption

A basic precondition for the economic success of fuelwood production systems is the existence of a local fuelwood market and proves to provide important incentives to tree planting. The possibility of selling small diameter logs from plantations and other AGF systems is seen to be essential, because they are an unavoidable byproduct if high quality lumber is to be produced (Current and Scherr, 1995).

Several studies have confirmed the role of AGF practices in offering economic incentives for their adoption. In Nepal, Bishwa (2003) studied the role of AGF to enhance the livelihood needs of households in marginal areas. The results indicate that changes in livelihood priorities and opportunities for earning income from the sale of fuel wood sales encouraged households to plant more trees on farms. In Central America, live fences which are very important for farm delimitation, preventing trespassing and keeping animals away from crops have been found to have the potential of contributing to fuelwood production. Reiche (1991) has emphasized that the introduction of live fences significantly impact on small farm incomes with an estimated internal rate of return of 28.80 percent.

User preference can contribute to the factors and challenges to adopting some fuel based AGF practices. Type and source of fuelwood material for specific agroprocessing activities are important. In Tamale Ghana, a study with different fuel wood species was conducted to ascertain the quality of smoked products and to determine consumer preference. The results indicated that eight locally available fuel wood species produced preferred colours in the smoked fish; and were classified as good fuel wood; while two imparted least preferred colours, and were considered bad

fuel wood (Obodai *et. al.,* 2009). Such products dependent on preferred fuelwood characteristics that make a significant contribution to the economy of the country count when making decisions about what species are to be planted in prospective local community or privately owned woodlots and plantations.

In Sudan, the important role of fuelwood as an energy source has led to the adoption of a regulatory system of planting and harvesting trees for charcoal production. In all other Eastern Africa countries except Sudan, obstacles to streamlining charcoal trade include inefficient production methods, poor marketing and its semi-illegal status. What must be done? (Mugo and Ong, 2006).

South Africa has gone a long way to use fast growing local species in community forestry and has studied the rates of regeneration of these local tree species for larger scale production of fuelwood (Shackleton, 2001). In Kenya also, AGF has been successful in reforestation and supports provision of fuelwood and fodder for ruminants in community managed woodlots and commercial private establishments (Nyamwange, 1990). However, success stories have not come without challenges and constraints.

2.11 Hindrances to adaptation of agroforestry technologies for fuelwood

The fact that woodlot farming requires farmers to set aside part of their land for growing trees, results in the cultivable area under food crops being reduced. Farmers with smaller plots of land are less likely to adopt woodlot technology and may view tree planting as competing with food crops, thus reducing incentives to establish woodlots. Nyadzi *et al*. (2003) reported that farmers in villages facing high land

pressure may lack enough land for experimentation with agroforestry technologies. Since land availability is an important factor that determines development of each of the components in the woodlot farming system, variation in the size of holding affects the tree cropping intensity. Farmers motivated to plant trees are faced with a shortage of available labour for food crop production (Adesina *et al*. 2000). Thus farmers whose main source of income is agriculture might be discouraged to allocate family labor for woodlots activities. However, several countries have experienced fuelwood security and soil improvement though rotational woodlot on small land fragments. Uganda and Tanzania have documented success in the adaptation of rotational woodlots as a solution to the challenge of fragments of land sizes owned by many poor peasant farmers in developing countries (Buyinza *et.al*, 2008, Nyazi, 2003).

2.12 Agroforestry research towards fuelwood tree species improvement

Meeting the demands of several, its expected productive function demands that tree species are fast growing which has led to a lot of research in diverse places including re-growth studies in South Africa (Shackleton, 2001). In India, Kataki and Konwer, (2001) studied multipurpose tree species growing in their natural habitat of north-east India for fuelwood characterization studies including various physico-chemical properties to identify species with preferred qualities.

In studies in Ghana by Manu and Ulzen – Appiah (1996) on agroforestry species for fuelwood plantation establishment, *Senna. siamea* was identified to be a better choice than *L. leucocephala* and *G. sepium* in terms of higher wood energy production per hectare, (385 x 106Kcal/ha). However, in terms of fuel burning quality expressed as Fuelwood Value Index (FVI) *Leucaena leucocephala* can be the best.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the study Area

The study was conducted in three Tain II forest fringe communities, namely Ayakomaso, Dumasua and Fiapre in the Sunyani District of the Brong Ahafo Region. The Brong Ahafo region is the second largest in size and population in the country with a territorial area and population of 39, 557, 08 square kilometers and 1.8 million people respectively. It has an average growth rate of 3.1 percent and approximately 73 percent in rural areas. (Ghana Statistical Service, 2000) It lies within the middle belt of Ghana and is also found in the forest savannah transition zone.

The Sunyani District (Figure 3.1) lies between 7°20' N , 2°20'W, and 7°33'N 2°33'W. It is located at an altitude of between 229 to 376 m. The district has a total land area of 2,488 km^2. Sunyani has a population of 61,992 representing 34.5 percent of the total regional population and a population density of 24.9 persons per square kilometer (Ghana Statistical Service, 2010). The population is ethnically diverse, the migrant population contributing significantly. Indigenous population consists of the Akan-speaking Brongs and Ahafos.

Ayakomaso, Dumasua and Fiapre (Figure 3.1) have individual populations of about 300, 600 and 2500 persons each (Ghana Statistical Service, 2000) and are 0.12km, 1km and 5km respectively from the Tain II forest reserve and have seven, one and two sawmills respectively. Fiapre, the most heavily populated of the three communities has a fast developing peri-urban area.

3.2 Climate and Vegetation

The vegetation is characteristic of areas that lie in the forest-savanna transition zone and drained by the Tain II river. The District falls within the wet semi-equatorial zone of Ghana with a mean monthly temperature of between 23 °C and 33 °C (Sunyani District Assembly, 1995). Rainfall is bimodal in the district with a peak rainy season from the end of March to July and again from September to November, after a short dry spell in August. The annual precipitation ranges between 1270-1780mm per annum (Holland, 1995). General soil characteristics in the study areas include forest ochrosols and savannah ochrosols and vary from well drained with high organic matter content in the forest area, to poorly drained with low organic matter content in the savannah belt (Zschekel *et al.*, 1997)

3.3 Economy of the district

The economy of Sunyani is predominantly agrarian with about 48percent of the active population engaged in agriculture. This is followed by the service sector which employs about 24percent of the population, 15percent for commerce and 13percent for industry, respectively (GSS, 2000). The communities are located near the borders of the Tain II Forest Reserve, a government gazetted forest reserve that is currently part of the implementation of a government forest rehabilitation plan.

Agriculture is an important activity in the study area. Maize is the most dominantly grown crop. Cowpea is grown by approximately 30 per cent of the farming population. Other important crops include yams, cassava, vegetables, plantain and cocoyam. Cowpea is usually mono-cropped; maize may be mono-cropped or

intercropped with cassava or other crops. Almost all farmers follow the bush-fallow cultivation system, with less than one third using chemical fertiliser. There are a lot of forest reserves including the Yaya, Tain I, Sawsaw, Nsemere and Tain II forests. According to the national timber inventory in 2002, the Tain II Forest Reserve is the largest area of forest reserve and is the most degraded reserve in the Brong-Ahafo Region.

3.4 Data collection and analysis

The sampling approach involved a combination of random sampling for households with the household head as the respondent, and purposive sampling for income generation activities that involved cooking and heating. Where the household head was not available, the oldest and most responsible family member was the respondent. However, on questions pertaining to the cooking or fuelwood consumption, women were specifically addressed. The survey was carried out between late September 2007 and January 2008. Structured, semi structured questionnaires and focus group discussions were used to collect data including domestic and commercial users of firewood, charcoal producers/burners and fuelwood traders including fuelwood suppliers and retailers, forestry staff, sawmill operators and village heads.

The questionnaire captured details of energy use in relation to heating and cooking, and their fuelwood preferences for each of these purposes. Information pertaining to frequency of fuelwood use, quantities, sources and unit cost if purchased. Households with a firewood pile on their compound at the time of the interview were requested to set aside the amount of wood they typically used within a day or week. Charcoal used was recorded in cost equivalents since most bought the charcoal they used. Income

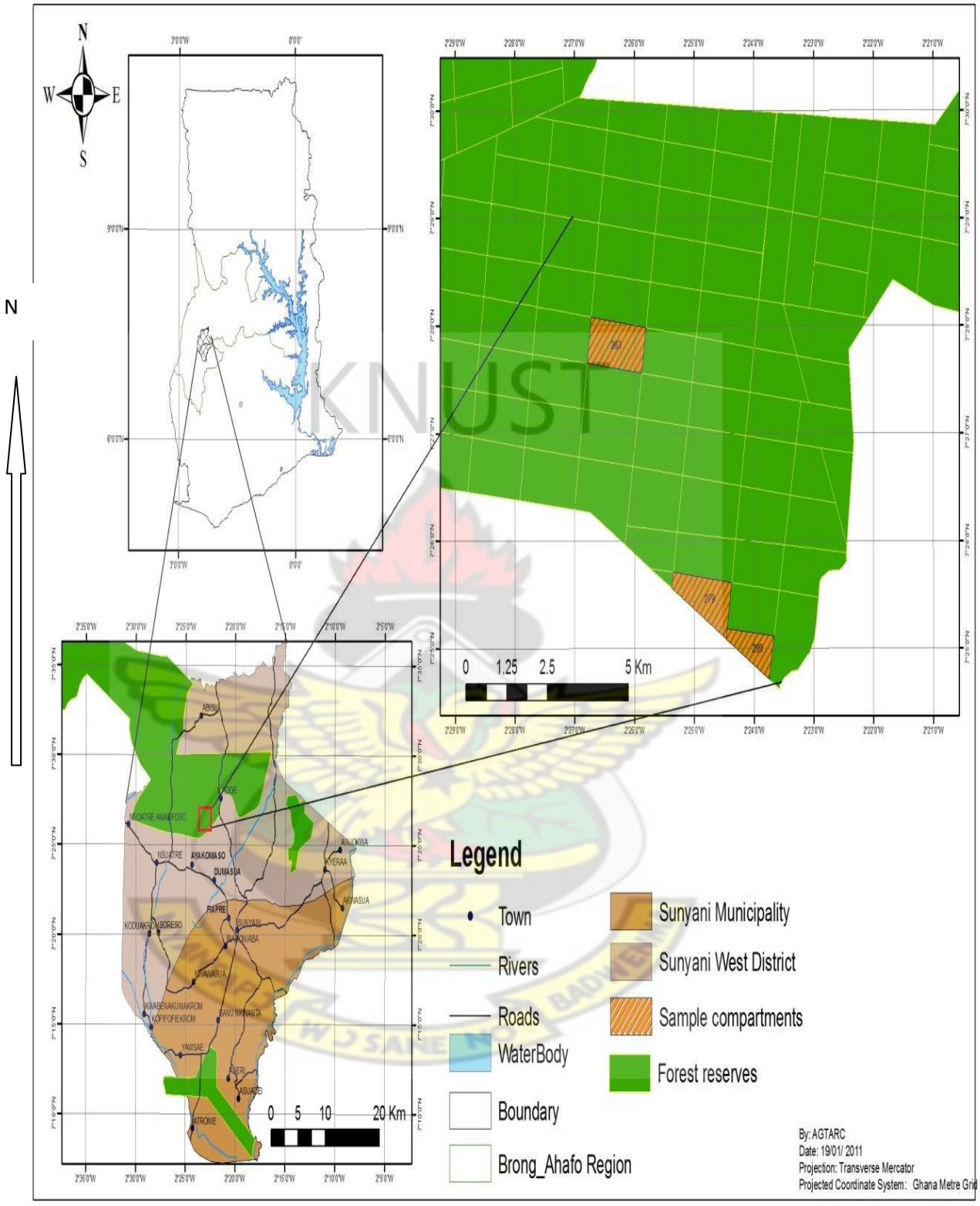
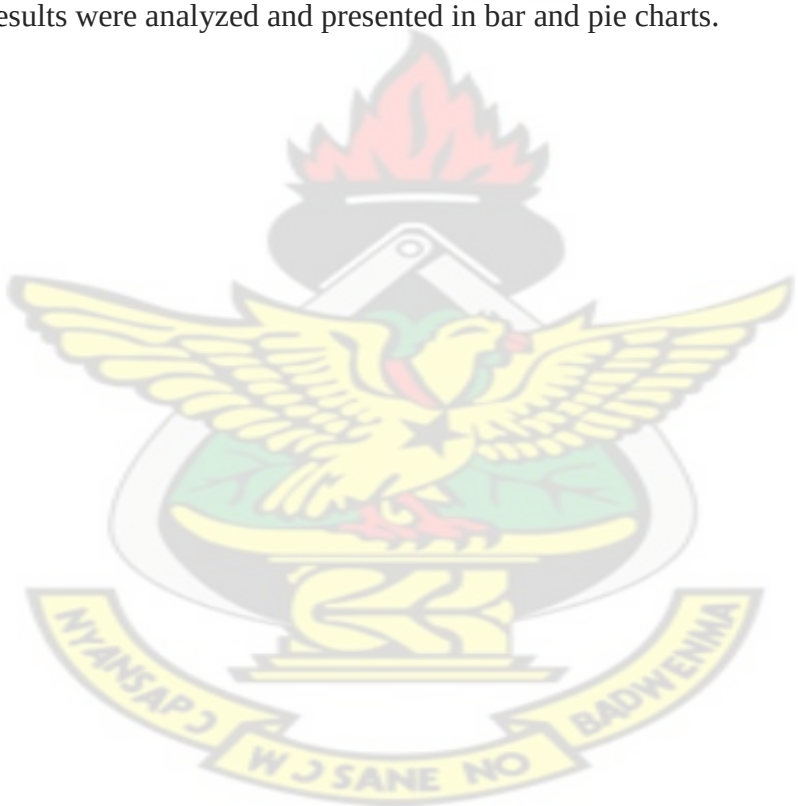


Figure 3.1 Location of study area (Agroforestry Project for Enhancing Rural Livelihoods, (APERL) Project GIS. Office, Faculty of Forestry Campus, KNUST)

per household was recorded and any other declared cash income from petty trading. The questionnaire was pre-tested in one of the study communities. A few modifications were made to make the data gathering easier.

A total of two hundred and forty respondents comprising one hundred and forty, sixty two and thirty eight from Fiapre, Dumasua and Ayakomaso respectively were interviewed. Basic socio-economic profile of the households was also captured. Data was processed and analyzed using Microsoft Excel and the SPSS software version 15.0. Results were analyzed and presented in bar and pie charts.



CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Respondents demographic characteristics

Results of the study showed that the age of respondents ranged between 18 and 68 years. 81.2 percent of were females and 18.8 percent males.

Table 4.1 Demographic characteristics of respondents in 3 communities in the Sunyani District.

	Fiapre (%) n= 140	Dumasua (%) n = 62	Ayakomaso (%) n = 38
Sex			
Male	17.10	12.90	34.21
Female	82.86	87.10	65.79
Education			
Nil	14.29	22.58	23.68
Basic	65.00	64.50	57.89
Secondary	16.43	11.30	15.80
Tertiary	4.28	1.62	2.63
Age range			
18-35	53.58	56.45	55.26
36 -53	39.28	24.2	31.58
54 - 68	7.14	19.35	13.16
Ethnicity			
Akan	43.57	43.55	36.84
North	23.57	17.74	26.31
Ga	12.14	8.07	10.53
Ewe	9.29	11.29	10.53
Bono	11.42	19.35	15.79
Martial Status			
Single	42.86	48.39	18.42
Married	34.29	29.03	63.16
Divorced	17.14	17.74	15.79
Widowed	5.71	4.84	2.63

A high proportion of respondents (65.0, 64.5, 57.89 percent of Fiapre, Dumasua and Ayakomaso respectively) had been educated at least up to the basic education level

(i.e. primary, JHS and MSLC levels), while Ayakomaso had the most proportion with no formal education (23.68 percent). The communities are ethnically diverse. Akans comprised the most in all three communities whereas 23.57, 17.74 and 26.31 percent from Fiapre, Dumasua and Ayakomaso respectively are of the northern extraction. These differences may have implications particularly for farmers' awareness and knowledge of agroforestry.

4.2 Forms and sources of fuelwood

The forms of fuelwood available in the district are firewood (off cuts and deadwood) and charcoal. The study shows the proportion of respondents' identified mode of accessing cooking energy in Figure 4.1. Majority of households (79percent) purchased fuelwood, 10 percent gathered from open vegetation whereas 6percent gathered from the forest as their main mode of accessing cooking energy. Firewood, although is freely available, is not easily accessed due to long distances travelled. Purchasing fuelwood is an indication that firewood is no more a free commodity. This does not correlate with hypothesis that many forest fringe communities may be poor but easily access forest tree resources for firewood.

With cash incomes mostly below the poverty line, buying fuelwood is a big financial pressure on community dwellers. Dwindling supplies and acute shortages of firewood were found to be due to several factors including slower rates of tree regeneration in open vegetation, increasing development pressure on available farmland for cropping and a steadily increasing population demand for firewood.

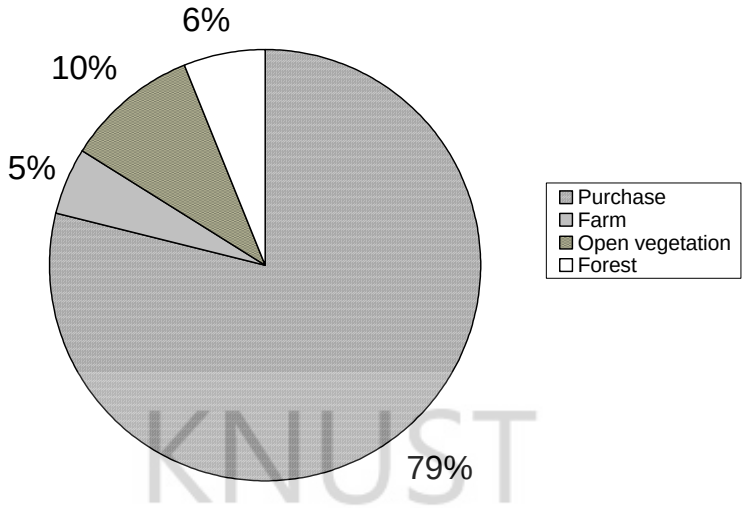


Figure 4.1 Percentage of respondents' sources of fuelwood.

Alternative firewood sources such as home gardens, boundary planting and woodlots within reach of the households may help meet energy needs of the rural poor. Fiapre having been observed to have a fast developing peri urban area was compared to Dumasua and Ayakomaso in their use of charcoal, firewood and LPG. The proportion of respondents using these forms of cooking energy is shown in Figure 4.2 below.

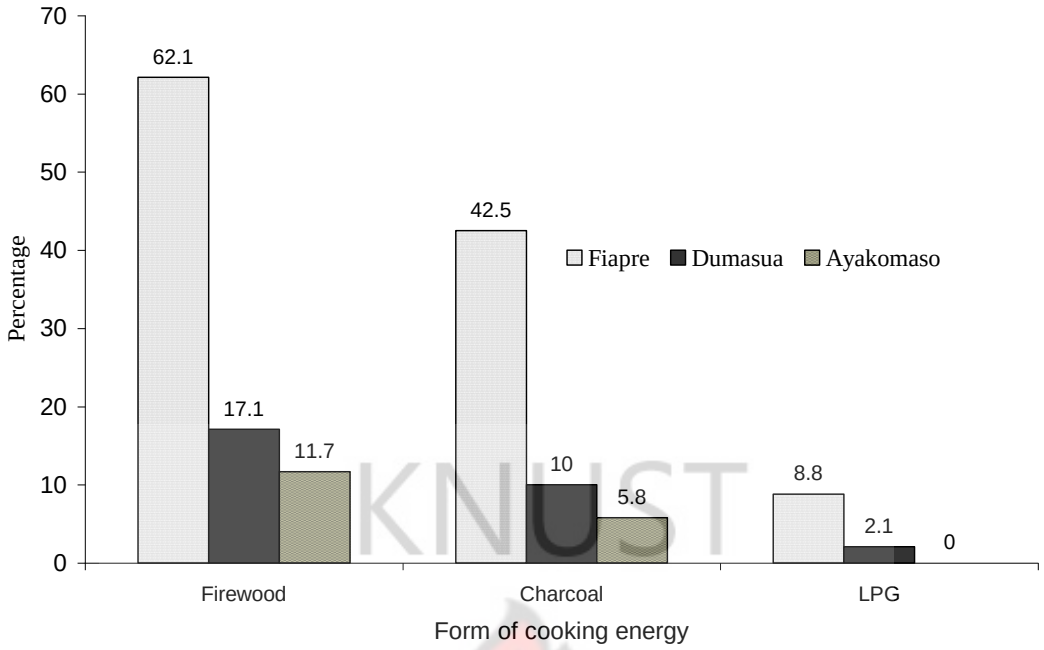


Figure 4.2 Proportions of respondents using different forms of cooking energy

The results show the proportion of respondents using various forms of cooking energy. It verifies the often held belief that rural households still dominantly use fuelwood for cooking and heating. The above results however correlate with findings of Tawiah (1995) in Ghana that showed demographic changes in rural local communities significantly contributed to over 70 percent households purchasing their fuelwood despite natural forest resources within and around the communities. A total of 90.9 percent of all responding households use firewood, 58.3 percent use charcoal and 10.9 percent use LPG (Figure 4.2). Gordon *et. al.* (2004) reported that greater than 90 percent of households in many African countries dominantly use biomass energy. However, KITE (1999) also observed that 70percent of the total national energy consumption is accounted for by biomass in either the direct or processed form and that the largest proportion of total energy consumed in the household is for cooking, with firewood and charcoal alone accounting for more than 93 percent.

Fiapre is also seen to have 42.5 percent of households using charcoal whereas less percentage of respondents use charcoal in the other communities. This percentage implies a good market for charcoal producers since demand is likely to continue to increase with persistent urbanisation. This indicates the gradually changing structure of the community into more of urban who are known to use more of cleaner fuels like charcoal compared to firewood.

4.3 Fuelwood and non-fuelwood-based income generation activities.

Apart from subsistence agriculture which is the principal occupation of the people in the study communities, other common income generating activities are food vending (14.6 percent), tree seedling production (11.7 percent), fuelwood production and sales (14.5 percent), poultry farming (8 percent) and food processing (25 percent). The distribution of the various activities between communities is shown in Figure 4.3. It is worthy to note that with 40 percent of respondents engaged in fuel dependent income generating activities, (and with the possibility of this number increasing as few alternative employment opportunities exist) there is no doubt that this would have implications on demand for fuelwood in the district and would lead to pressure on the Tain II Forest Reserve. It is imperative that efforts are made to ensure that any expected increase in demand and use of fuelwood for activities aimed at sustaining the livelihoods would be met through the conscious production of fuelwood using appropriate agroforestry interventions.

4.3.1 Income from off-farm activities

Off-farm income generating activities are important in sustaining rural and farm households as they come in to supplement income that farmers earn from their

farming activities. The different IGA and the proportions of respondents involved in them are represented in Figure 4.3.

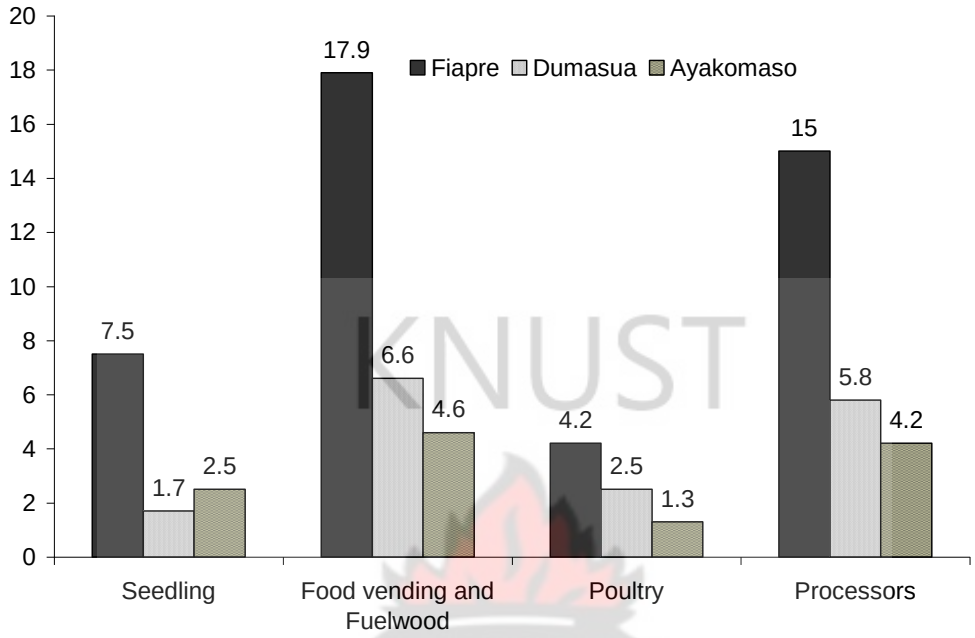


Figure 4.3 Common Incoming Generating Activities among respondents

They are particularly important during the off seasons when farming activities go down. An assessment of income earned by farmers from off- farm activities indicated that farmers from Ayakomaso, Dumasua and Fiapre on the average earn GHc 9.00, GHc 11.50 and GHc 17.00 respectively on a weekly basis (Table 4.2). It is not surprising that households from Fiapre, the most commercialized of the communities potentially can earn higher income than the others. Where these activities are fuel-based, then demand for fuel wood correspondingly would be higher.

Table 4. 2 Weekly (range and average) off-farm income earned

Community	Minimum Income (GH¢)	Maximum Income (GH¢)	Average Income (GH¢)
Fiapre	4.00	30.00	17.00
Dumasua	3.00	20.00	11.50
Ayakomaso	3.00	15.00	9.00

Source: Author's field data, 2007

4.3.2 Fuelwood sale as an income generation activity

Fuelwood production and sale is one of the important income generation activities in the district in particular and in the Brong Ahafo Region in general. Migrants are engaged in the production of charcoal.

Firewood consumers such as bread bakers, schools, fish-mongers, palm oil processors etc often depend on sawmill off-cuts to meet firewood needs in time of shortages. The price ranges quoted for fuelwood wholesale supply and retail are given in Tables 4.3 and 4. 4. Some indigenous species including Esa (*Celtis zenkeri*) and Pepea (*Magaritiaria discoidea*) were found to be the most expensive. At the time of the study, prices were rising due to increased transport costs. This observation is in agreement with studies which have emphasized that transportation costs are key in setting prices of fuelwood and charcoal (World Energy Assessment, 2000).

Table 4.3 Price of firewood from various sources in the Sunyani District

Fuelwood	Cost (GHc)
Indigenous (Esa and pepea)	
Kia truck load (2 tonne)	100.00 – 120.00
Push truck load (4kg-7kg)	6.00
Head load (2kg-3kg)	1.20
Sawmill	
Kia truck load (2tonne)	60.00
Push truck load (15kg-20kg)	4.00
Head load (2kg-3kg)	0.8 to 1.00
Other species	
Kia truck load (2tonne)	80.00 to 90.00
Push truck load (15kg-20kg)	5.00
Head load (2kg-3kg)	0.80 to 1.00
Teak	
Kia truck load (2tonne)	70.00
Push truck load (15kg-20kg)	5.00
Head load (2kg-3kg)	1.00

Source: Author's field data, 2007

Sometimes, the strategy of these processors is to team up and buy firewood in bulk. The cost of a 2 tonne capacity Kia truck load (Plate 4.1) is shared between 2 to 5 people to cut down on the amount of capital invested. This is usually the case if they live within very close by households. This makes sharing and movement it into storage places easier for all.

Table 4 .4 Price of charcoal (GHc 1.00 = USD1.00)

Packaging	Supply Price (GHc)	Selling Price (GHc)
Indigenous (Esa & Pepea)		
Jute bag (10kg-12kg)	7.00	8.00
Rice bag (5kg- 7kg)	2.50	3.00
Take away bundle (500g-1kg)	-	1.50
Other species		
Jute bag (10kg-12kg)	5.00 -5.50	6.0-7.0
Rice bag (5kg- 7kg)	2.40	2.80
Take away bundle (500g-1kg)	-	0.10
Teak		
Jute bag (10kg-12kg)	5.00	6.00
Rice bag (5kg- 7kg)	2.00	2.50
Take away bundle (500g-1kg)	-	0.10

Source: Author's field data, 2007

Plate 4.1 A Kia truck load load (2 tonne) of firewood from Ayakomaso to Fiapre.

4.4 Fuelwood consumption of households

Average weekly expenditure on domestic fuelwood and by representative households in the three communities was assessed. The average weekly expenditure of households on fuelwood is GHc 1.65, GHc 0.80 and GHc 0.70 for Fiapre, Dumasua and Ayakomaso respectively (Figure 4.4). Charcoal was found to be dominantly used in Fiapre hence a flourishing market. This seems to reflect a demonstration of the relationship between household income and energy use. Charcoal is often the main 'transition' fuel to which people shift first from firewood (Barnes *et al*., 2002). Results showed clear evidence that charcoal is used alongside firewood in many households.

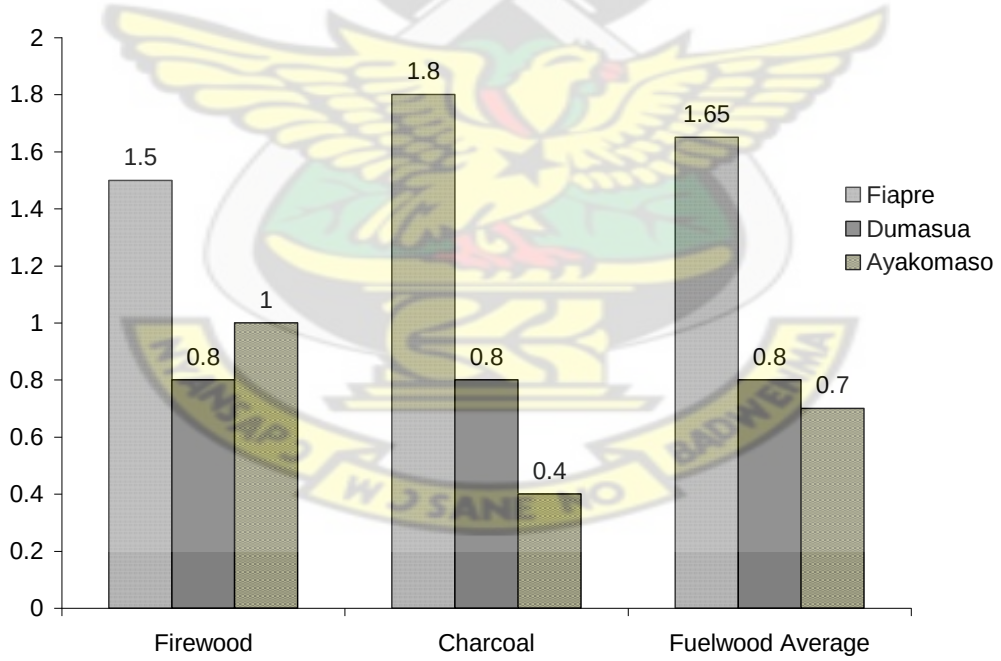


Figure 4.4 Average weekly expenditure on fuelwood for domestic use.
Fiapre N = 30, Dumasua N = 10, Ayakomaso N = 14

It was observed that while some households used charcoal most for cooking and heating, it served as a more convenient fuel for reheating of meals especially because

it reignites easily. Many households however were found not to cook very often because it seemed cheaper to buy meals compared to buying fuelwood to cook meals. Fuelwood expenditure was found to be up to 27percent of the weekly cash income of households. As such, meals are bought in the late mornings since households are poor and most cannot afford a three square meal. This behavior resounds the findings of Abakah (1990) that the proportion of a family's budget spent for energy (direct and indirect) is inversely related to level of income owing to the fact that low-income families tend to assign a significantly larger share of their income to energy. The dependence on energy is thus relatively greater. An increase in the cost of energy therefore has a relatively greater impact on lower-income families.

Residents in Fiapre seem to have more opportunities to exploit cash income earning activities serving as casual labourers, security service officers in institutions. Despite this, households cannot afford LPG which is unreliably supplied. In surety of charcoal demand therefore, some households disclosed gathering firewood gradually and selling off in bulk to any interested charcoal burner for a relatively large sum of money instead of selling off petty head loads collected daily. This is parallel to Wood and Baldwin (1985) assertion that as a consumer good, charcoal competes with other commercially available fuels, such as kerosene, propane gas, electricity, and marketed fuelwood. Fiapre is a growing peri-urban area and may have better cash income earning opportunities around. Dumasua and Ayakomaso respondents were observed to spend far less on charcoal because of cash constraints and also for the fact that they have relatively easier access to firewood which is cheaper though less convenient to use. This confirms Wood and Baldwin (1985) assertion that charcoal use is dependent on its price.

Many commercial income generating activities include food vending, local beer (pito) brewing, whereas industrial activities like gari and Palm Kernel Oil (PKO), peanut paste processing, bread baking, fish smoking, local soap production. These activities involve the use of fuelwood thus a regular high demand on fuelwood in addition to domestic fuelwood needs. The percentages of respondents who use fuelwood in these different sectors in shown in Figure 4.5

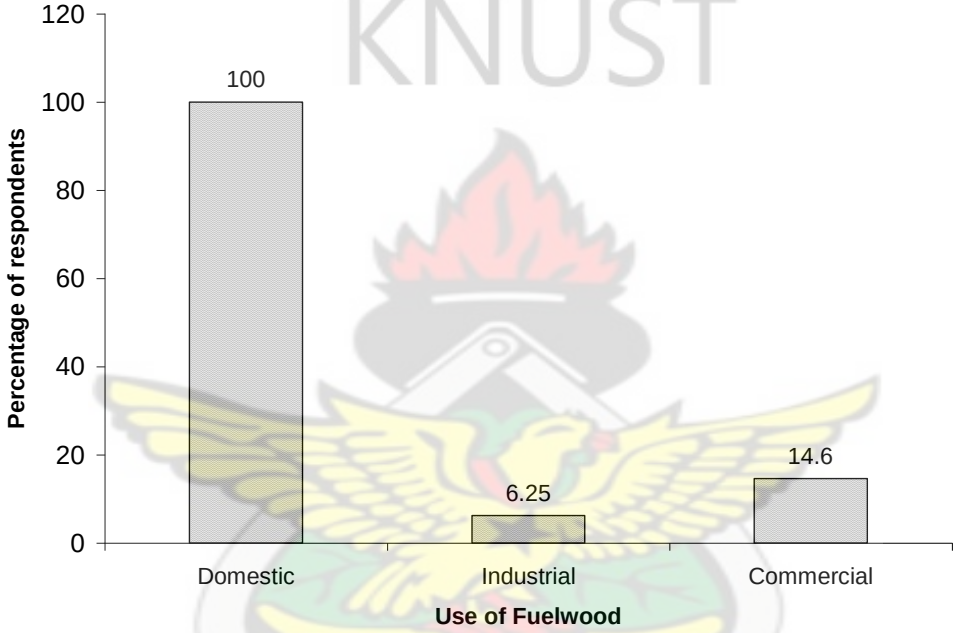


Figure 4.5 Use of firewood in various sectors within all three communities

Commercial users were found to use more of firewood than charcoal and were mainly food vendors. Processors were found to use firewood quantities ranging from 2 head loads(2kg-3kg each) to 1 push truck (15kg-20kg) load per day of economic activity whereas food vendors were found to use between 1 head load and 1 push truck load of firewood. Charcoal was mainly used for reheating and quantities used ranged between 1 retail package valued at GHc 0.10 for charcoal whose weight ranges between 500g-1kg depending on the density of the wood. An average household's (4 to 5 people)

firewood needs range within ½ to 1 head load (1.5kg - 3kg) per day, or 1kg - 3kg of charcoal depending on what meals are cooked.

4.5. Potential impact on fuelwood trading enterprise

The fuelwood enterprise is in several dimensions including the tree resource production (tree growing), the charcoal production and the sale of fuelwood. This discussion focuses on charcoal production, the sale of fuelwood, awareness of agroforestry, constrains to the access of fuelwood and the potential of adopting tree growing among households.

4.5.1 Firewood supply

One common source of firewood for domestic use is the supplies from chainsaw operators who are given permits by FSD to clear forest floors of deadwood to prevent forest fires. These supplies are not sufficient since FSD limits access to the forest due to abuse of the permit via illegal logging. Deforestation and desertification setting in and their persistence make it a challenge to have regular readily available firewood supplies. As a result, indigenous firewood species are reported to have virtually vanished. Households now have to depend on any suitable readily available alternatives especially deadwood gathered from the farms and open vegetation.

The impact of long distances travelled to the forest and poor access roads is that many households have the tendency to resort to charcoal use which is comparatively expensive. This stimulates the firewood business and it has led to the proliferation of several firewood wholesale and retail businesses within these communities and creates employment for those who split logs especially in Fiapre (Plates 4.2 and 4.3).

Distance to forest is positively related to charcoal consumption and negatively related to firewood consumption. This indicates that time involved in firewood collection plays an important role in household energy decisions indeed (Chen *et a.l* 2006). Yet, it is relatively easy to invest into the firewood trading business because all you need is a little capital especially for transportation, some credibility, space to pile and a couple of yards of polythene sheets to cover it up during the rains. Demand for firewood is high due to poverty. However, several wholesalers report persistent pressure to supply the next batch of firewood. Retailers earn GHc 30.00 per 2tonne firewood load sold. Firewood trader earns averagely GHc 30.00 and 120.00 per month. Charcoal suppliers earn larger profit margins per 2tonne capacity truck supplied because of the compact and portable nature of charcoal. This makes firewood supply a challenge.

To improve firewood supply, the integration of trees in cropping systems can provide significant financial benefits to the rural farmer, given the existence of a local firewood market. In Swaziland for instance, Manyatsi and Hlophe (2010) report that the sale of firewood contributes significantly to the livelihoods of firewood sellers who make between US$ 67 and US$ 133 per month considering that 69 percent of the population of Swaziland live below the poverty line of US$2 per day.

4.5.2 Charcoal supply trade

Charcoal traders constituted 14.6 percent of respondents. Charcoal sales (Plate 4.4) demand more from the investor in terms of capital to start the business. This is because charcoal costs more than firewood and there is also the need to purchase

Plate 4.2 Splitting big logs to usable sizes attract cost before retail sale in Fiapre.

Plate 4.3 Firewood split into usable sizes on retail sale (GHc0.5 - GHc1.0)

packaging sacks. One is required to be able to pay off about 70 percent of the cost of supplies. This is because the suppliers of charcoal are dominantly from Kintampo and Wenchi who travel between 112 km and 70 km respectively to deliver charcoal. Traders make 20 percent profit per jute bag of charcoal and are able to sell between 10 – 100 bags per month depending on the market base and the season of the year. A regular and significant proportion of this charcoal supply can come from the local Sunyani charcoal burners. This opportunity could be exploited even more intensively for improved livelihoods if tree growing is adopted to supply the needed firewood raw material.

Plate 4.4 Bags of charcoal on display for sale as an income generation activity

Assessment of poverty between 1995 and 2003 by the World Bank (2005b) shows that forty five (45) percent of Ghanaians live below US$1 per day. Integrating agroforestry into farming systems for fuelwood production has the capacity to improve rural livelihoods. Regarding the likelihood of viability of charcoal trade, Amoh – Anguh (1998) asserts that the quantity and cost of production of fuelwood

depend 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). Clearly, charcoal trading having been identified as contributing 60percent of Internally Generated Funds in Wenchi district by the Ghanaian media (Ghana Chronicle, 2006) depicts its importance to rural livelihoods.

4.5.3 Firewood species preferences for cooking and heating.

The proportion of respondents who identified tree species commonly used for heating and cooking are listed in Table 4.5. Although the indigenous species are commonly preferred, their dwindling supply compels households to shift to available exotic species like teak for firewood. The most preferred species however are *Khaya grandifolia* (Mahogany), *Terminalia ivorensis* (Emire) and *Milicia excelsa* (Odum).

The *Celtis spp, Senna siamea, Khaya grandifolia, Mangifera indica* and *Magaritaria discoidea* are seen to be dominating and readily identified in Table 4.5 as available trees that may be equally utilized for other purposes but are also used for cooking fuel. It is evident that households are increasingly shifting to the Less Utilized Species (LUS) and Less Known Species (LKS). For instance, *Celtis spp* and *Magaritaria discoidea* are widely sought for both firewood and charcoal and are also very scarce in Sunyani. This is reflected in their prices as the highest peaked shown in Tables 4.3 and 4.4.

Table 4.5 Identified tree species for cooking and heating among respondents

Local Name	Scientific Name	*Frequency (percent)
Esa fufuo	Celtis mildbraedii	63.3
Esa kokoo	Celtis zenkeri	70
Pampena	Albizia adianthifolia	12
Pepea	Magaritaria discoidea	75
Kane /African birch	Anogeissus leiocarpus	40
Dahoma	Piptadeniastrum africanum	10
Cedrela	Cedrela odorata	30
Cassia	Senna siamea	75
Onyina	Ceiba petandra	40
Onyamedua	Alstonia boonei	12
Duabankye	Dialum aubrevillei	12
Bese	Cola nitida	10.0
Mango	Mangifera indica	60.0
Mahogany	Khaya grandifolia	80
Kyenkyen	Antiaris toxicaria	40
Emire	Terminalia ivorensis	45
Faldherbia/Acacia	Faldherbia albida	30
Sinuro	Alstonia boonei	41.6
Nyankyerene/ Sandpaper tree	Ficus exasperata	30
Odum	Milicia excelsa	15
Wawa/African white wood	Triplochiton scleroxyl	50
Akonkodie	Bambax buonopozense	24
West African Bombax	Bombax brevicuspe	20
Kokrodua	Pericopsis elata	13.3
Akye	Blighia sapida	10
Albizzia	Albizzia *spp*	30.0
Otie	Pycanthus angolensis	13.3
Leucaena	Leucaena leucocephala	20.0
Teak	Tectonia grandis	30.0
Sesbania	Sesbania sesban	25
Moringa	Moringa *spp*	6.0
Calliandra	Calliandra calothyrsus	23.3
Dahoma	Piptadeniastrum africanum	33.3
Ofram	Terminalia superba	45.0
Bomsamdua	Distemonanthus benthamiaus	15.0

* Percentages add up to more than 100 percent because of multiple responses

This seemed to be the major factor that contributes to the loss of the fuelwood market to the Kintampo and Wenchi suppliers. Qualities most sought in firewood were the ease of split, clean burning and extensive burning. Some odd observations were also

made among identified tree species. For instance, *Ceiba petandra*, *Bombax brevicuspe and Bombax buonopozense* recorded 40percent, 20percent and 24percent respectively. These were observed to be the case because of the scarcity of preferred species for fuelwood. Respondents have no option but to use any available species for firewood.

Among all the species identified as used for fuelwood, respondents were asked to identify their preferred five (5) species out of the lot. Table 4.6. shows the percentage of respondents and their corresponding choice of tree species for firewood.

Table 4.6 Most preferred utilized tree species for firewood

Local Name	Botanical name	Percentage
Esa	Celtis zenkeri	12.1
Kane	Anogeissus leiocarpus	6.3
Cassia	Senna siamea	14.6
Pepea	Magaritaria discoidea	10
Mango	Mangifera indica	12.5
Onyina	Ceiba petandra	13.4
Teak	Tectonia grandis	10.8
Pampena	Albizia adianthifolia	7.5
Nyankyerene	Ficus exasperata	6.4
Akye /Ackee	Blighia sapida	6.4

These choices were made out of 11 species including *Esa*, *Kane*, Cassia, *Pepea*, and Mango, Teak, *Pampena*, *Onyina*, *Kyenkyen*, *Nyankyerene* and *Akye* which were ranked by the likehart scale. The species were selected based on the identification of the trees usefulness for several common purposes like fodder food, and their availability or its dominant use for charcoal burning by charcoal producers. These will

need to be taken into consideration while making choices for tree planting especially woodlots.

4.5.4 Charcoal burning as an income generation activity

Charcoal burning is an important income generation activity within all three communities. Plate 4.5 depicts on-going charcoal burning and sale activities in one of the research communities (Fiapre). This activity has proven to be a viable business in the district and faces competition with supplies coming from other districts notably Wenchi and Kintampo. This is because of shortages, insufficiency and scarcity of the needed wood as raw material. Although there is free firewood in the Tain II, charcoal burning is not allowed in the forest due to potential forest fires. The alternative is to transport the wood to an area less prone to forest fires. This will however increase production cost.

Currently, charcoal burners in Sunyani use a combination of preferred species with any other available wood for charcoal burning if they have access to wood at all. *Tectonia grandis* and other species including *Senna siamea* deadwood from boundary tree planting in institutions, homesteads and avenue trees are gathered and piled over time with push trucks. *Terminalia ivorensis* is a premium species and prefered for its export value so is not available for fuelwood at all. Teak is also suitable for firewood because of its high calorific value but hardly used for charcoal production because it sparks a lot in the burning process. Interestingly, it is the most abundant species available for firewood and charcoal from the Tain II forest. Other species like *Leucaena leucocephala* and *Albizzia spp* are widespread and coppice fast but needs a lot of management.

Sufficient quantities of firewood resource material to make a minimum of 20 bags is gathered knowing that the charcoal burning procedure is a laborious task and takes days of close monitoring to make a reasonable income. Charcoal from *Senna Siamea* is preferred over teak among consumers because of its cleaner burning quality.

Most charcoal producers do not plant trees for firewood but gather from surroundings. A few private woodlots which are intended to be harvested and sold more for poles instead of firewood were found in the district. This is an indication there is the likelihood that, farmers might be willing to take steps towards meeting firewood needs through the establishment of woodlots if well educated on the potential. The approach must be intensive since tree regeneration rate is not as fast as the consumption rate of fuelwood.

A potential source of firewood for charcoal production in the study communities is the use of off-cuts and other sawmill residues. The presence of 7 sawmills within vicinity of the communities makes the use of these wastes possible. Previously, sawmill waste was a last resort for firewood. Sawmill firewood used to be free and was often times burnt. This is not the case anymore. It is sold for cash and can thus be used for charcoal production also.

4.6 AGROFORESTRY AWARENESS IN THE COMMUNITIES

Majority of the respondents in all three communities (67 percent) were found to be aware and had fair knowledge about agroforestry and other tree planting activities and the potentially positive impacts they can have on the economic well-being and

livelihoods of the communities. The extent of awareness of agroforestry practices among respondents in the three study communities is shown in Figure 4.6.

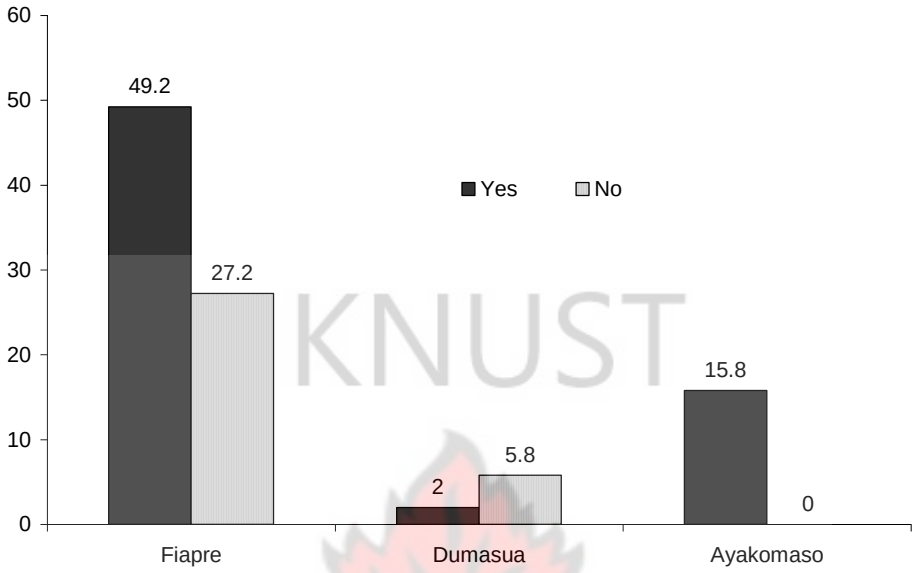


Fig 4.6 The degree of awareness of AGF in the 3 communities

Agroforestry practices identified in these communities include the modified taungya system, woodlots, biomass transfer, bee keeping, alley farming, fruit trees, green fences. It was found that farmers still have some trees on farms. They were asked the reasons behind this. Reasons were found to be diverse including shade, medicinal value, fodder, firewood and soil improvement.

Community members were very much aware of AGF (Figure 4.6). Describing it as incorporation of trees into farms, they quickly identified with it. The launching of the Agroforestry Practices to Enhance Resource – Poor Livelihoods (APERL) Project in the year 2007 contributed was noted to deepen community awareness of agroforestry. Similarly, improving dominant soil degradation and shortages in fuelwood in the tropics with multipurpose trees has led to a widespread creation of awareness by the World Agroforestry Centre (ICRAF). It has invested into farmer focused projects over

the years in collaboration with donor funded or support schemes and has resulted in widespread adoption of tree species for multiple benefits. These have steadily yielded scaling up results in improving livelihoods in several rural areas.

4.6.1 Adoption of tree planting, agroforestry and identified tree benefits

Respondents were asked of their main reasons for which they would plant trees. This helped to give insight into expected features of trees in general. It also helped to identify benefits of trees which are attractive enough to farmers that would induce them to invest in or manage a fuelwood plantation if given the opportunity. Most people identified growing trees for cash (Figure 4.7). Fast growing trees were indicated as the number one feature. Respondents seemed to be more interested in trees whose cash value is high and equally in high demand so that benefits are recouped fast enough. For example, teak is said to cost GHc144.00 per cubic metre and so most respondents expressed interest in planting teak.

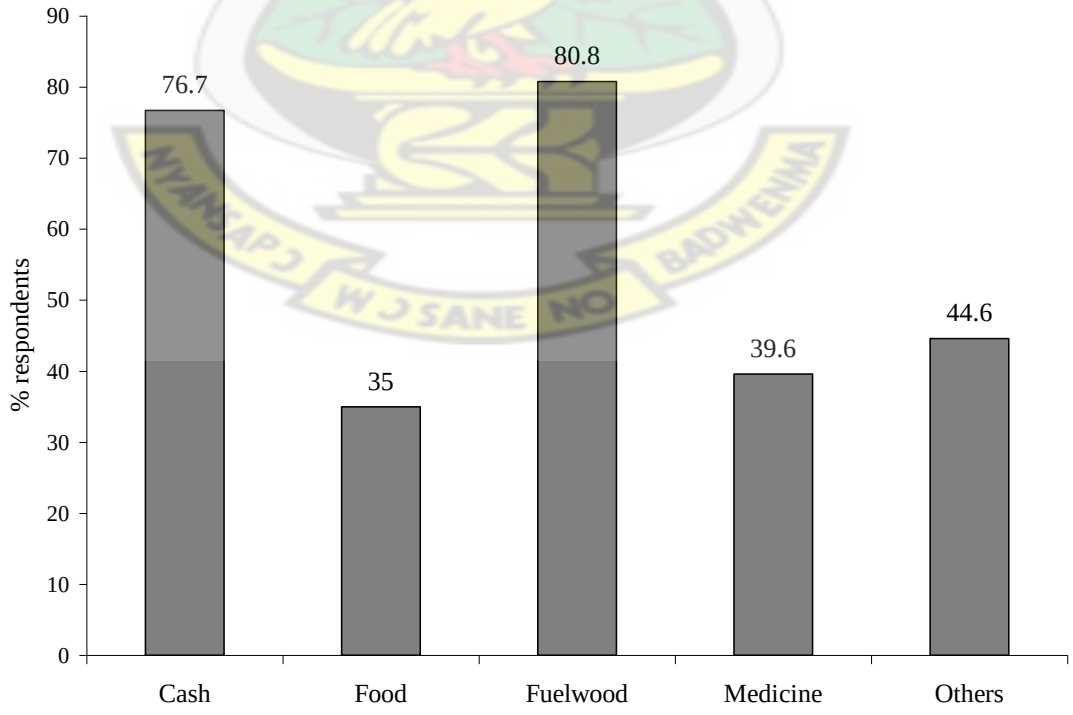


Fig 4.7 Identified tree benefits among respondents in the three communities.

The most common forms of agroforestry were seen to be home gardens and trees on cropland as well as planting trees on home compounds. However, many homes have different species of trees on home compounds, used especially to provide sun shade and wind shield. The most prefered and planted in most home gardens was found to be citrus and used mainly as a source of food (fruit), firewood, as well as a source of income through the sale of the fruit. The degree or extent of adoption of these practices is however too low to make any significant impacts in the production of firewood for domestic and commercial use. To make any impact, there is the need for intensive education. The capacities of farmers need to be built so that their knowledge of various agroforestry practices can be enhanced. Only then would there be any likelihood of wide scale adoption agroforestry practices for fuelwood production.

The preference for teak can be ascribed to its fast growth, resistance to pest, and fire tolerance features compared with many indigenous species. Teak plantations do not provide the various non-timber products that are provided by natural forests or indigenous species plantations which are able to sustain ecological diversity as well as providing communities with sustainable livelihoods (Bosu *et. al.,* 2010). Moreover, planting trees is currently seen as an alternative livelihood strategy, particularly in drier areas where the drought is frequent, soils are very poor, and fertilizers and improved seeds use are risky and less profitable (Pender et al., 2006).

The respondents' fair knowledge of trees and the services of extension officers due to the taungya system is useful for the possible establishment of woodlots in the near future. Generally, focus group discussions revealed that certain factors count in the

decision making process of the adoption of agroforestry and the type of trees to be planted. Most important factors identified include technical knowledge support from extension agents, knowledge of the coppicing nature, features of the species (pest resistance and fast growth), the management practices required through the years of establishment, and the multiple purpose benefits of the species such as food and fodder, the calorific value, density and its soil improvement ability. These were found to be important to the farmer since it determined how much labour they would need to put in till trees are mature for any stage of its multiple benefits. This confirms assertions by Adesina *et al*. (2000) and Nyirenda *et al*. (2001) that more widespread knowledge of the activities of the forestry extension programs could have a positive impact on farmers' decision to manage woodlots on their farm fields.

4.7 Constraints of accessing fuelwood and adopting agroforestry for fuelwood

Several constraints were identified as hindering the access of fuelwood available within the three communities. These were:

i. *Deforestation, shortages and scarcity of tree resources in open vegetation*:

As much as these communities are forest fringe communities, increasing population, persistent poverty and subsequent dependence on fuelwood over the years has led to vast extents of woodlands being depleted of tree resources preferred for fuelwood purposes.

ii. *Distances travelled collecting dwindling fuelwood*:

The preferred woodland tree resources in Sunyani have persistently been felled for fuelwood and so women and young girls cannot risk going further. For instance,

development activities release land four housing and infrastructure etc but these are often very far off from homes where heavy loads of wood are needed but cannot continually be transported on foot.

iii. Haulage and transport costs:

Although Ayakomaso has seven sawmills and is closest to the Tain II plantation forest, its abundant deadwood from pruning and sawmill off cuts is far off from households especially Dumasua and Fiapre. Teak is not necessarily preferred for fuelwood but is used in the absence of preferred species. Haulage labour and transport costs moving small log pruning and off cuts as fuelwood is expensive thereby raising the price. Price of permits and off cuts contributes to increasing costs.

Several other constraints were also identified as hindering the adoption of agroforestry practices and tree planting in general. These include:

i. Small land holdings for cropping, tree and land tenure systems

Interaction with respondents showed that migrant charcoal burners barely consistently crop fields whereas indigenes who have access to fragments of land for cropping can hardly allocate land for woodlots growing targeted at charcoal burning. Tree tenure is a concern for farmers who do not own the land they crop.

ii. The potential low price of tree resources cultivated for charcoal production.

Generally, land cleared for housing or cropping is the source of fresh or deadwood for charcoal production. Although open vegetation is practically diminished of tree resources, cultivated tree resources intensively tended over years before

harvestable maturity is feared to have very little potential to fetch good prices as an alternative to using land for basic food cropping and its associated risk of food insecurity.

iii. Frequent bushfires.

The Brong Ahafo Region is typically known for being prone to frequent bush fires due to charcoal production activities. Respondent households feared risking to lose years of investment in a fire possible outbreak.

Findings of Buyinza and Mukasa (2007) show a higher likelihood that farmers will adopt nitrogen fixing multi-purpose trees especially because of other benefits such as fuelwood and fodder for farmers. To make the fuelwood market enticing enough within the localities, it may be important to focus on community based institutional efforts and that of stakeholders to produce and secure a sustained supply of the trees for firewood and charcoal production in the locality. That way, raw material (wood) would be readily available, transport costs eliminated and preferred trees planted especially for charcoal production. Mixed species may be planted to prevent devastating losses associated with pests. Demonstration woodlots projects with fast growing trees, rotational woodlots on fragmented farms and the use of fire resistant trees might be desirable.

4.7.1 Motivators important for the exploitation of the market for fuelwood

Focus group discussions identified that if trees are locally grown in woodlots, home gardens and live fences, the current effort of gathering or collecting deadwood for domestic use and charcoal production will be minimized. Charcoal producers

expressed deep concern that in addition to the laborious task of making the earth mound, they now have to gather and transport wood for burning charcoal. In lieu of this, technical and financial support may be necessary towards kiln production of charcoal with readily available off cuts from sawmills and deadwood from forest floors. General motivating factors for small scale farmer to take advantage of existing markets include:

i. Multiple benefits as cost benefit ratio analysis insure food security. If trees have multiple benefits such as human food (fruits and nuts), medicinal value or fodder among several other benefits, farmers are likely to adopt growing trees for firewood.
ii. Attractive prices of wood products for charcoal will encourage farmers to incorporate trees into cropping systems or even allocate land solely for tree cropping hence an improved livelihood
iii. Faster establishing trees and faster coppicing of trees imply a shorter rotation and turn over for farmers' cash flow.

The above observations confirm Scherr (1995) generalizations that agroforestry evolves in response to land use intensification, resource constraints implication on different agroforestry practices and associated risk. Obviously, there is the need for intensified efforts towards more sustainable sources of fuelwood in the communities seeing it is a growing viable enterprise. Having other developing countries to have taken the lead, there is confidence that needed income could be realized either as a major target benefit or a by – product of any adopted agroforestry technology.

Finally, the contribution of forests and open wooded vegetations to livelihoods through the provision of rural cooking energy needs in these three communities cannot be overemphasized. Indications that dependence on fuelwood is not likely to change anytime soon is enough incentive to invest into securing localized fuelwood production and management to ensure local consumption is catered for and possibly exploited for an improved livelihood especially via charcoal production.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

This has been a study to explore and describe fuelwood production and supply and the role of fuelwood based income generation activities, as well as to identify gaps fuelwood availability in the Sunyani District of the Brong Ahafo Region. From the results obtained, the following conclusions can be drawn:

5.1 Conclusion

i). Sources of Fuelwood

Most households in Dumasua and Ayakomaso meet their domestic firewood needs by gathering or collecting from open vegetation, farms and the Tain II forest. Fiapre on the other hand purchases fuelwood and is heavily dependent on other districts (New Logoro, Wenchi and Kintampo) for charcoal and some firewood supplies. Charcoal producers do not plant trees for fuelwood but gather from available firewood in surroundings.

Seventy nine percent of respondents purchase fuelwood while others supplement from other sources since many do not want to walk the distance to the Tain II to collect free firewood. This experience of diminishing sources of fuelwood in immediate and surrounding environments continually depletes the little cash earned and with time contributes significantly to an environmentally degraded community through firewood extraction and subsequent loss of biodiversity of indigenous species. There is the need to diversify the firewood sources through incorporation of appropriate and easily managed land use practices.

ii). Sources of income

Households are poor subsistence farmers with very low cash incomes. Their principal sources of income in order of importance are subsistence agriculture and forest related livelihoods. Current specific income generating activities include poultry, food vending agro-processing and petty trading. The forest related livelihoods are fuelwood trading, tree seeds gathering and seedling nursing etc. Though fuelwood sales, agro-processing, poultry and tree seedling nursing are potential sources of income for the households, these can only be feasible for adoption when there is a reliable and sustainable source of fuelwood within the communities.

Diverting from agriculture and to forest based forest related activities, it is not too sustainable since teak monoculture plantations that can be found in the district do not provide much of what the natural forest does for livelihoods especially when the canopy closes. Petty trading is thus resorted to for a diversified livelihood depending on the seasons. These fuel based activities could be incorporated into farming activities as extra sources of income to boost cash income earned especially during the off farm seasons.

iii). Income generating opportunities in fuelwood supply and production.

Fuelwood is still the most dominantly used cooking energy. Firewood is collected from open vegetation and farms and also purchased from sellers in the communities. Although communities studied are forest fringe communities, there is a frequent experience of shortages (especially of the preferred local species of firewood) which stimulates the fuelwood business opportunity. The majority of households purchase fuelwood for their domestic and commercial activities. Nevertheless, the high cost of

transport contributes to high prices of charcoal in the district making the poor struggle for the least firewood in sight. Several fuel based income generating activities suffer due to shortages, dwindling availability of firewood and high prices of firewood. Fuelwood sales are a promising income generating activity and provide opportunities to improve the livelihoods of the rural people of the three communities.

iv) Community awareness and agroforestry

Households are aware of tree planting and agroforestry technologies and their potential role in solving their fuelwood needs. As a result of this knowledge, a couple of households were observed to have adopted some agroforestry for the production of firewood for domestic and commercial purposes.

Respondents expressed interest in AGF systems and technologies like trees on croplands and woodlots to improve the fuelwood supply situation and help contribute to improving rural livelihoods. Although having preferences for indigenous species such as *Esa* and *Pepea* for fuelwood, there is a lot of interest in Teak cultivation because of its cash value. Many farmers are also interested in incorporating soil improving trees into farming systems.

v Constraints to access fuelwood and adoption of agroforestry technologies

Although forest fringe communities, Fiapre, Ayakomaso and Dumasua experience scarcity and frequent shortages of fuelwood. Domestic fuelwood needs and that of fuelwood dependent income generating activities are not sufficiently met by local source supplies. Many have to resort to purchasing fuelwood needed for cooking and heating. The price of fuelwood keeps increasing due to inflation that affects fuelwood

transport costs from Wenchi and Kintampo, which are major suppliers. The persistent increase in the cost of fuelwood does not auger well for the rural poor who are already cash constrained. The current trend of fuelwood shortages results in women and children walking long distances to gather fuelwood.

There are only a few young woodlots established within the communities studied. Charcoal producers are therefore not able to sustain supply of charcoal due to the scarcity of suitable raw materials. Small fragments of landholding, land and tree tenure, the slow growth and coppicing re-growth rate of tree species and lack of requisite knowledge were found to inhibit the adoption of agroforestry technologies.

5.2 Recommendations

The study recommends that:

i. Households incorporate live fences using fruit trees with fuelwood qualities to help control animals, contribute to food security and cash incomes while also providing for fuelwood needs.

ii. Home gardens are intensified in homesteads to help the dwindling fuelwood situation, provide fodder and other service functions in addition to serving as a source of improved livelihood while eliminating the distances walked to gather fuelwood.

iii. Fast growing rotational tree woodlots be adopted into farming systems since landholdings are small and dispersed. This would be easier to adopt on an individual farmer basis as compared to woodlots which will afford benefits

only within the few years of tree establishment. Such investments could also be efficiently be undertaken by schools, community groups, and private enterprises.

iv. Education of farmers through demonstration plots and workshops needs to be intensified to create awareness and stimulate interest in self initiated farmer adoption of agroforestry technologies of his choice. This will go a long way to contribute to an enriched environment, improved livelihoods and a better encouraged and satisfied farmer.

v. A more efficient charcoal production system be established close to the Tain II forest to utilize dead wood and off cuts for charcoal production in the immediate future. This will generate income within the communities and hopefully reduce expenditure on firewood by some margin.

5.3 Further research opportunities and suggestions

As much as several tree crops are recommended for soil fertility improvement and other multiple benefits, it is important that area specific research needs are carried out for the matching of legume trees to site conditions so that trees are exploited to the maximum in adopted agroforestry technologies. There could be further research into growth rates of cultivated common indigenous species. This will likely increase the chances of their adoption if findings turn out to be favorable.

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APPENDIX

QUESTIONNAIRE

Community Name…….

Background of respondents

1. Sex: 1) Male 2) Female

2. Age: below 18 (1); 18-35 (2) 36-53(3) above 53 (4)

3. Marital Status: (1) Married Single Divorced Widow

4. Level of Education: Nil (1) Basic Miiddle (2) Sec/Voc/Tech (3) Tertiary (4)

5. What is your ethnicity? (1) Akan (2) Northerner 3) Ga (4) Ewe (5) Bono

6. Number of dependants ……

Objective One: To identify the sources and forms of fuelwood accessed and used

7. What is your dominant source of fuelwood?

a) Purchase (b) Open vegetation (c) Farm gathering (d) Forest prune gathering

8. Do you have access to farmland? Are you a farmer? a) Yes b) No

9. What form of energy do you dominantly use?

a) LPG (b) Charcoal (c) Firewood (d) Others

What do you supplement with? ……..

Objective two: To describe fuel consumption and its impact on the fuelwood trading enterprise

10. What off farm income generation activities are you involved in?

(a) Fuelwood sales. b) Processing c) Seedlings sales/ gathering d) Poultry e) Others

11. What is your weekly income (off farm) on market days ?.....…….

12. Please state your average weekly expenditure on fuelwood below

Firewood (GHc)	Charcoal GHc)

13. What is the cost of packages of fuelwood supplied and sold on the local market?

	Wood type	*SP	*CP	Firewood (GHc)	Charcoal GHc)
Kia Truck					
Charcoal jute bag					
Head load					
Truck load					

* SP - Selling Price and CP – Cost Price

14. How much fuelwood are you able to sell?

	Firewood (GHc)	Charcoal GHc)
Daily		
Weekly		

15. Please tick your most preferred of the these three characteristics of fuelwood

a) Clean burning b) Elongated burning c) Ease of split

16. Rank fuelwood species according to preferences for charcoal and firewood

Species	***Charcoal***	***Fuelwood***	***Rank preference***	***Characteristics***	***Uses***

Objective 3: Awareness of agroforestry, tree planting and potential for its adoption

17. Are you aware of agroforestry? a).Yes b.)No

18. Please tick the benefits of trees that you perceive

a) Cash b) medicine c) fuelwood d) food/fruits e) others

19. Which tree species would you like to plant if you have options and why? …….....

Objective 4: To examine the Constraints and challenges of accessing fuelwood species and adopting agroforestry in within the community.

20. What is total size of land you crop?.....

21. Are you interested in planting trees as sources of fuelwood? Yes /No

22 How much fuelwood are you able to gather within a week? ……

23. Are there adequate supplies of your preferred species? Yes/No

24. Do you experience shortages of fuelwood for your income generation? Yes/No

Focus Group discussion

25. What are the most preferred species for fuelwood ?.....

26. What are the most available fuelwood species?……

27. List your alternative fuelwood materials?.....

28. Any issues/conflicts/disputes regarding fuelwood in the community? …….

FUELWOOD PRODUCERS AND MIDDLEMEN

1. Do you produce/sell any fuelwood/charcoal ? Yes/ No

2. What quantity of charcoal would u produce at a time?…….(No of bags)

3. How often do you produce charcoal ?.....

4. What are the sources of your raw materials for charcoal burning ?

a). Forest reserve b). Open vegetation c). Saw mill d). off cuts

5. Which of them is most regular source?.....

6. What quantities are you able to produce in a day/week/month?.....

7. Are there any fluctuations in prices of fuelwood/charcoal? a).Yes b)No.

8. Describe the fluctuations please……..

9. What are some of your challenges to supplying your customers?.....

10. Do u have any credit facility? a).Yes b)No

11. What tree species do you prefer to use for charcoal and why ?…….....

…….

12. Are you interested in planting trees as sources of fuelwood? a).Yes b.)No

13. Can you identify an area where tree planting could be introduced in your area?.....
.

14. Do you foresee to problems arising with tree planting for this purpose? Name or describe them please……

15. Do you have access to land is for tree planting ? a).Yes b)No

16. Are you aware of agroforestry and tree planting? a).Yes b)No

17. Apart from tree products for fuelwood or charcoal, what other benefits would you like from trees planted for fuelwood? a). food/ fruits b).