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SUSTAINABILITY OF ANNUAL EXTRACTABLE VOLUME OF FIREWOOD FROM CHIPA FOREST RESERVE, DODOWA, GREATER ACCRA REGION, GHANA

This Dissertation is Presented to the Department of Theoretical and Applied Biology in Partial Fulfilment of the Requirement for the MSc. Degree in Environmental Science

BY

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DECLARATION

I declare that this thesis entitled '**Sustainability of Annual Extractable Volume of Firewood from Chipa Forest Reserve, Dodowa, Greater Accra Region, Ghana** is the result of my research findings, prepared and submitted to the Kwame Nkrumah University of Science and Technology Kumasi-Ghana, Department of Theoretical and Applied Biology, College of Science in partial fulfillment of the requirements for the award of Master of Science Degree in Environmental Science. References to the work of others have been duly acknowledged.

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DEDICATION

All thanks to God almighty for his protection, and for enabling me thread smoothly on this journey to achieve this academic feat, and it is for this reason that I sincerely dedicate my work to Him.

This thesis is also dedicated to the most important person in my educational career, my husband, George Nana Etrue Oppan, father, Hon. Yaw Baning –Darko and mother, Mrs. Mercy Baning-Darko, for consciously encouraging me to complete this work.

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Acronyms

EC **Energy Commission**

EPA **Environmental Protection Agency**

FAO **Food and Agricultural Organisation**

FC **Forestry Commission**

FSD **Forest Services Division**

FWP **Forest and Wildlife Policy**

GDP **Gross Domestic Product**

GMet **Ghana Meteorological Agency**

GSS **Ghana Statistical Service**

ITTO	**International Tropical Timber Organisation**
IUCN	**International Union on Conservation of Nature**
MLNR	**Ministry of Lands and Natural Resources**
MLF	**Ministry of Lands and Forestry**
NTFPs	**Non-Timber Forest Products**
NGO	**Non-Governmental Organisation**
NRMP	**Natural Resource Management Programme**
SFM	**Sustainable Forest Management**
UNCED	**United Nations Conference on Environmental Development**
UNFCCC	**United Nations Framework Convention on Climate Change**
WCMC	**World Conservation Monitoring Centre**
IGBP	**International Geosphere- Biosphere Programmes**
IHDP	**Infant Health and Development Program**

ABSTRACT

Firewood is one of the main products of the forest. The bulk of energy supply in Ghana is met from charcoal produced from firewood. Firewood, therefore, accounts for the total primary energy source in Ghana. The indiscriminate collection of firewood is gradually degrading the Chipa Forest Reserve. This therefore called for this study to ensure the sustainability of the forest reserve. The study covered 140 families, 20 families each from 7 fringe communities. Questionnaire administration and actual calculation of volume of firewood were the instruments used in collecting data. The statistical tool, analysis of variance was employed in analysing the data collected. Findings from this study show that the use of firewood among rural folks is still at a dangerous level, despite the government's attempts to discourage the use of firewood by introducing liquefied petroleum gas (LPG). The people of Ghana are so much glued to firewood usage that a change in preference for fuel source seems a near impossibility. The habitants of study area consumed 2,424.240 m^3 of firewood annually. The forest reserve has a capacity of 10,443.400 m^3, which will

serve the study population for only 55 months. This calls for the need to ensure a sustainable use of firewood. Since the demand for this forest product is high, measures aiming at producing firewood should be considered. The Development of Forest plantations in Ghana especially in locations where firewood is a source of livelihood should be strategised to support the sustainable growth of trees used as firewood. This will ensure enough production of firewood that will meet the demand of the

Ghanaian populace. Increase in production of firewood will also improve on Ghana's vegetation (forest) cover and this will help reduce the effect of climate change in the country and in the world as a whole.

CHAPTER ONE 1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

The total land size of Ghana is 23.85 million hectares (ha) of which 4,940,000 ha (20.70%) is forested area and 5.3% (1,264,050 ha) is primary forest which is the most biodiverse and carbon dense form of forest (Owusu J. G. K, Abeney E. A. and Frimpong E. A, (1999). Two hundred and sixty thousand hectares (1.09%) of Ghana's land is planted forest (Owusu *et al*., 1999).

The primary forest contains 1,185 identified species of birds, reptiles, mammals and amphibians according to the data provided by the World Conservation Monitoring Centre (WCMC, 1908). Out of these 0.8% (9) is endemic and 3.0% (36) are threatened (WCMC, 1908). Ghana is a habitat of at least 3,725 vascular plants species of which 1.2% is endemic and 4.6% are protected under IUCN categories I – IV (Bane of Forest Reservation, 2013).

Forests designated for the production of timber are mostly located along the south western section of the country, Ghana. Forest types range from wet-evergreen to semideciduous (Owusu *et al*.1999). Forest lands are mainly owned by extended families in local communities and traditional authorities. However, forest resources, whether outside or inside forest reserves, are controlled, managed and protected by the Forestry Commission of Ghana (Marfo, 2010). Economically, forestry and logging contributed 3% of Ghana's GDP in 2009 and this contributed US$240.9 million to the total export value (Ministry of Lands and Natural Resource (MLNR), 2011). It is estimated that about 120,000 individuals

are gainfully employed by the forest sector and this provides the source of livelihood for about 2 million Ghanaians (MLNR, 2011). According to Boakye E, Odai S. N, Adjei K.A, and Annor F. O**,** (2008), changes in vegetation cover are often as a result of anthropogenic pressure and natural factors such as variability in climate. Destruction of forest woodland has impacted negatively on catchment processes, biogeochemical and hydrological cycles and this has resulted in soil erosion and water shortage (Abeney, 2006).

There have been increasing rates of forests and woodlands conversion in developing countries all over the world due to increasing population (Groten S. M. E, Inamerzel W. and Leeuwen L.V, (1999). Also, increasing need for wood and land for agricultural purposes are because of population pressure. Developments in science and technology have contributed to the destruction of most forests (Ahmed, 2008). Much strain on the forest has also been as a result of, increasing interest in ecological forestry in terms of genetic biodiversity. Fringe communities' involvement in forest protection has caused a strain on forest resources (Ahmed, 2008).

The International Tropical Timber Organisation (ITTO), of which Ghana is a signatory, launched its Target 2000, aimed at ensuring that trading in tropical timber products will be obtained from forests which are sustainably managed by the year 2000 (Ministry of Lands Forestry (MLF), 1994). In order to halt the effects of deforestation, some European countries decided to restrict the importation of tropical timber. Ghana responded by enacting the Forest and Wildlife Policy (FWP) of 1994 to reflect and address the challenges of forests loss and land cover change (MLF, 1994).

1.2 OBJECTIVES

1.2.1 Main Objective

The main aim of the present study was to determine the sustainability of the annual extractable volume of firewood from the Chipa Forest Reserve and its impact on the reserve.

1.2.2 Specific Objectives

The specific objectives were to determine;

- The quantity of firewood extracted annually from the reserve
- The uses of firewood in the fringe communities
- The quality of preferred tree species as firewood
- Reasons for preferred species and their impact on the forest reserve.

1.2.3 Research Questions

To gain a better understanding, the following research questions were formulated in order to gain more empirical information about firewood consumption in Chipa Forest Reserve, Dodowa.

- Has the Chipa Forest Reserve much firewood to sustain the seven fringe communities?
- Do the communities depend solely on the reserve?
- How much access do the communities have to the reserve?

- Are they satisfied with the adequacy and species of firewood resources available?

1.3 JUSTIFICATION

The United Nations Food and Agriculture Organization (FAO) in the year 2000, brought to bare, the actions and inactions of changes in population in a local settlement. This may differ from very decisive changes in population to negligible changes and that deforestation can result from population pressure and dormancy in the economic and social conditions of the local setting.

The occurrence of deforestation be it naturally or human induced, is an ongoing problem in several countries in the world. Deforestation results in the extinction of plants, animals, micro and macro organisms (Bane of Forest Reservation, 2013). Deforestation affects the changes to climatic conditions and desertification. It also affects dislocation of populations, as seen by present and past conditions through fossil records (Bane of Forest Reservation, 2013).

Some factors of forest degradation on the other side have gained benefits that can be economically measured and most times put money into people's pockets. This makes the factors of degradation appealing and attractive (Kalu *et al* 2010). Many important forest functions have no markets meaning, no economic value that is practically seen by the communities which depend on the forest for their survival (Kalu *et al* 2010). From the understanding of the developing world, the gain of the forest as a carbon reservoir and habitat for biodiversity pertains to developed countries and there is meagre compensation for the intangible services (www.carboncycle.biz, 2007-2014).

Deforestation in Ghana is regarded as being the result of the harm caused by industrialisation and activities of humans (Bane of Forest Reservation, 2013). The protection of the forest requires a minimization and elimination of the existing causes of damage, the avoidance of additional forms of damage and the preservation and natural use of the environment (Bane of Forest Reservation, 2013).

The forest reproduces tangible and intangible benefits. Benefits such as timber and nontimber products required for human consumption are known as the tangible benefits. Intangible benefits are control of eccentric rainfall, stability in climate, gains in agriculture and soil enrichment, and wind breaks (Shah, 2016). Deforestation does not pertain to a geographic area or a particular group of people; rather the effects of deforestation affect the total global region (www.chainsawpartsstore.org). What strategy is Ghana employing locally to arrest the deforestation which is on-going in every part of the world at such an alarming and abnormal rate? The effect of deforestation is huge and it affects the standard of living of the local people. It disrupts important environmental forest functions and destroys the original forest composition.

Ghana's forests are dwindling due to over utilisation of forest products and use of forest land for agriculture. In order to re-establish forests for future generations, it is necessary to reduce considerably the frequency of firewood fetching (Ghimire B. K. and Pimbert P. M., 1997).

People living around the Chipa Forest Reserve depend on the reserve for firewood. Due to this the forest has dwindled at a fast rate. They harvest the fresh trees and dry them for firewood. The communities trade in firewood and also use firewood daily for their energy

needs. There is, therefore, the need for the present study to assess the sustainability of the current rate of extraction of firewood from the forest reserve and its impact on the forest.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 World's Forest Resources

The Forest harbours about seventy percent (70%) of terrestrial plants and animal species in terms of providing food, shelter, oxygen, recreation and spiritual sustenance (rainforestconcern.org). The forest is also a source of livelihood for humans in terms of traders in the trading of over five thousand (5,000) commercial products (Mensah, 2011).

The FAO report in 2010, disclosed an alarming rate of deforestation, which indicated a global annual loss of forest vegetation of about 13 million hectares in the last decade which is 2000 - 2010. More than half of Ghana's total forest cover is deforested. The report affirmed that, Africa is the second highest continent that destroys forest at a fast rate worldwide (with 3.4 million hectares of forest lost annually). The World Resources Institute (2015) estimated that about 22% of the original world's forest cover still remains; these forests are the Canadian and Alaskan boreal forest, the boreal forest of Russia, the tropical forests of the north- western Amazon Basin and the Guyana Shield (Guyana, Suriname, Venezuela, and Columbia).

2.2 Ghana's Forest Resources

In 1990, Ghana's forest cover was 7,448km^2. In 2000, 2005 and 2010 the forest cover was 6,094 km^2, 5,517 km^2 and 4,940 km^2 respectively. Trends in industrial round wood removal in 1990, 2000, and 2005 were 1,382 m^3, 1,298 m^3 and 1,508 m^3 respectively (FAO, 2006). Also, firewood removal in 1990, 2000, and 2005 were 14,833 m^3, 23,780 m^3 and 23,780

m^3 respectively (FAO, 2006). Prior to the launch of the Urban and Rural Promotion Programme in Garu-Tempane in 2013, the government of Ghana provided free gas cylinders just like it was done in 1990 to encourage the use of liquefied petroleum gas (Aglina, 2014)

The FAO (2010) report has estimated that Ghana's deforestation rate is at 135,395 ha per year.

2.3 Effects of Land Use on Ghana's Forest Resource

Recurrent droughts in the northern and southern parts of Ghana have a great influence on agricultural activities; overgrazing, deforestation, poaching, habitat destruction, and soil erosion threaten wildlife populations. Also, water pollution causes inadequate supplies of potable water. Ghana will lose its current forest cover if measures are not put in place to control the rate of forest destruction (Bane of Forest Reservation, 2013).

Deforestation is caused by some human activities such as harvesting a forest and changing the original state to a non-forest use. This happens for various reasons of which some are charcoal burning, pasture for livestock and fuel wood (MLNR, 2011). The harvesting of forest trees and non-forest trees without any proper plans to replant has caused destruction to plant and animal shelter hence making them fall prey to harsh economic and environmental conditions (Gyasi E.A. Agyapong, G.T. Ardayfio-Schandorf,

E. Enu-Kwesi, L. Nabila, J.S. and Owusu Bennoah, E. (1995). This has various impacts on bio-sequestration of atmospheric carbon dioxide. In recent times, the rate of forest degradation has increased in Ghana (Gyasi *et al* 1995).

Deforested areas normally suffer severe soil erosion and most of the time degenerate into a wasteland (MNLR, 2011). According to Hawthorne and Abu-Juam (1995), the forest of Ghana is converted into savanna wood lands and the existing savanna woodlands converted into near desert. Also, the main causes of forest degradation in Ghana are forest clearance for cash crop farming such as cocoa, cashew, shea butter and recently palm. Food crops farming and logging have also added their quota to forest destruction. This was supported by the FAO (2006) report that clearing forest lands for agriculture is the main cause of deforestation not in Ghana only but rather in all of Africa.

Ghana's forest cover of 8.2 million hectares had been estimated to have declined to about 1.7 million hectares in the mid-1980's (Hall, 1987) and about one million by the mid-1990s (Forest Services Division (FSD), 1996). Due to this dwindling trend, the Forestry sector in Ghana has lost its major role and influence in the National Economy. The timber industry used to be the third largest export earner after gold and cocoa, contributing 6% to GDP and 18% of total export earnings in 1994 (Ministry of Lands and Natural Resources, 2011). Today, reports from the sector Ministry indicate that the forest accounts only for about 4% of GDP and 11% of national export revenue, a decline of 2% and 7% respectively over the past five years.

In many countries, clearing of the forest by both natural and human induced activities is an ongoing thing. Deforestation encourages the changes in climate, desertification, displacement of people and extinction of species (Bane of Forest Reservation, 2013).

In 2000, the United Nations Food and Agricultural Organization (FAO) detected that the role of population changes in a local setting may vary from decisive to negligible and that deforestation can result from a combination of population pressure and stagnating economic, social and technological conditions (Bane of Forest Reservation, 2013).

Recently, biodiversity has become easy target for human consumption due to increasing human population and the pursuit for better life; this has increased the rate of exploitation (Turner, B. L. Clarke, W.C. Kates, R. W. Richards, J. F. Mathew, J. T. and Meyer, W.B, 1990).

2.4 Economic Benefits of Forest and Wildlife Resources to Ghana.

Estimatedly, about 120,000 individuals are formally employed by the Forest and Wildlife sector, and this serves as a source of livelihood for about 2 million people (FAO Report, 2000). There are about 84 sawmills that are of good standing (sawmills that are legally registered and have access to raw materials to feed their mills) in Ghana. There are also 12 companies that are of good standing with plywood capacity in the formal sector. These directly employ about 120,000 people who have averagely 2 dependants (Mattos, Z. Brandino, and I.C.G. Vieira (2007).

Forestry related jobs and products accounted for 3% GDP in 2009 and contributed USD 240.9 million (representing 7.6%) to total export value. An expansive mix of actors, rural and urban households depend on forest resources for their livelihood. This ranges from small scale carpentry, hunting, illegal chainsaw operations and fuel wood collection to the gathering and commercialization of diverse non-timber forest products (NTFPs) (Manyimadin, 2015). An estimated 11 million people live in forest areas of which about 67% of livelihoods in the forest areas are supported by forest activities. It is estimated that there are about 5,000 people engaged in regular hunting, with an estimated income of USD 1,000.00 per year (Mensah, 2011).

Exports of wild plants and animals were evaluated at USD 18 million in 2003 (World Bank, 2006). Although there are very high importance of forest and wildlife resources to the national economy, the extent of the contribution of non-timber forest products (NTFPs) are not formally recorded and remain inadequately represented in policy analysis (www.clientearth.org). The primary sources of energy in Ghana are from the forestry sector comprising of 94.5% firewood (Strategic National Energy Plan, 2006). Biomass, in the form of firewood and charcoal dominate the total energy consumed in the country, averaging 67% in 2008, (MNLR, 2011).

2.5 Contributions made by Ghana's Forest and Wildlife Policy.

Ghana continues to operate on the basis of sustainable forest management principles and procedures since the approbation of the 1994 Forest and Wildlife Policy. It as well has laws and other legislature including the Plantations Development Fund Amendment

Act of 2002 (Act 623), the Forestry Commission Act of 2005 (Act 543), the Timber Resources Management Act as amended (Act 547 of 1997 and Act 617 of 2002), the Timber Resources Management Regulations Act of 1998, the Forest Protection Decree of 1974, the Forest Protection (amendment) Act of 2002 (Act 624) and Trees and Timber (Amendment) Act of 1994 (Act 493). These laws provide the framework of the functions of the Forestry Commission (FC) in sustainably managing the forest resources of Ghana and prescribe the quality the qualifications and procedures for the allocation of timber concessions and participation in plantation development. These laws also prescribe the rights of local communities and the payment of forest fees by the forest resource users (Owusu, 1999).

Marfo (2010), reported that about 80% of Ghana's forests have been destroyed by illegal logging despite the laid down procedure and laws regarding forest exploitation and management. The Forestry Commission of Ghana records that USD256 million in illegal timbers leaves the country each year. Most of these timbers enter Europe (Marfo, 2010).

The Forestry Commission is doing better in monitoring activities to achieve the objectives of the Master Plan than in evaluating impacts of the plan. This shows that not much work has been done to evaluate the impact of anthropogenic effects on changes in Ghana's forest cover since the adoption of the concept of Sustainable Forest Management (SFM) and the Forest and Wildlife Policy in 1994 (Owusu, 1999).

The strict regulations for timber concessions, chainsaw operations, mining activities, and agricultural and commercial logging activities have been laid down to be adhered to and implemented with deterrent disciplinary measures (Gyasi *et al* 1995). The law indicates that

it is illegal to commence a project without an environmental assessment that will eventually provide an environmental permit. Industries, Non-governmental Organisations, Inter-governmental Organisations, farming communities and the general citizens whose activities directly caused deforestation have laid down procedures as to how to go about their business.

The forestry sector in Ghana has more laws guiding the management of forest resources than any other sector in the environment. In line with this constitutional provision, a national policy on forest conservation and deforestation has been provided. In the international sphere, Ghana has signed on to almost all environmental policies and conventions. Ghana is a party to conventions such as, the International Timber Agreement and the African Convention on Nature and Natural Resources.

2.5.1 Forest Policies and Sustainable Forest Management (SFM)

The 1948 policy on Sustainable Forest Management (SFM) led to increasing emphasis on central government administration, control and ownership of the country's forests.

Forest Reserves in Ghana belong originally to the people but are invested in the state. Due to this, it is very necessary that management of the forest is done with the involvement of the people who own the resource. According to Tufour (1996), there were an accumulating marginalization and even alienation of local communities in the administration of forests, a trend towards forestry being practiced only by foresters for the nation's benefit; this trend lasted from the late 1980's until the 1994 Forest and Wildlife Policy was enacted. The 1994 policy was to 'sustainably develop and conserve the nation's forest and wildlife resources

for maintenance of environmental quality and perpetual flow of benefits to all segments of society" (MLF, 1994). This policy dwelt on environmental protection, sustainable production and use of forest and wildlife resources (MLF, 1994). It also concentrated on involvement of local people in management and benefit sharing, institutional restructuring and promotion of research and human resource development. A Forestry Management Development Master Plan was developed in 1996 to execute the policy through a comprehensive donor-funded sector development programme, the Natural Resource Management Programme (NRMP) (MLNR, 2011).

2.6 Implementation of Forestry Legislation and Its Challenges

In Ghana, generally, law enforcement is weak and this has affected forest law enforcement. The theory of "human face" to the judgement of all forest offences has made it difficult for the implementation of laws enacted to protect forest resources. Since 1998, chainsaw milling has been declared illegal in Ghana but up till today, chain saw lumber is found in timber markets. Exploitation is about 2.5 million cubic meters of lumber annually (Marfo, 2009). The illegal trade also employs about 100,000 people. Nutakor E, Marfo E, and Tutu P. O, (2009), observed increased levels of urban and rural unemployment. Also, corruption amongst law enforcement agencies including the Forest Services Division (FSD) and the police has contributed to continuous existence of the illegal trade.

2.7 IMPACT OF TREE FELLING ON FOREST STRUCTURE

Rampant and indiscriminate tree felling have destroyed the forest lay out in Ghana. This has resulted in the difficulty in evaluating on a broad geographic scale, the composition of and the implication on, biodiversity. Logging increased the probability of recurrent fire in the Amazonian rain forest (Uhl C, Verissimo A. Mattos M. M, Celia I, and Brandino Z**,** 1991). According to Muchaal and Ngandjui (1999), hunting activities near settlements substantially reduce the abundance of mammalian species.

2.8 SUSTAINABLE FOREST MANAGEMENT (SFM)

The idea of sustainable forest management began after the UN Conference on Environment and Development (UNCED) in 1992; it included social and environmental dimensions besides the economic aspects of forest use. The concept defined SFM as: "The process of managing permanent forest land to achieve one more clearly specified objective of management with regard to the continuous flow of desired forest products and services without undue reduction in its inherent values and future productivity, and without undue undesirable effects on the physical and social environment" (ITTO Report, 2006).

2.9 SUSTAINABLE FOREST MANAGEMENT IN PRACTICE

Owubah, C.E. Le, Dennis M, Bowker C, Lee J, M. and John G. (2001), in their study used a market framework to analyze the relationships between individual components of forest tenure and sustainable forestry practices in Ghana, and their outcome was that the

involvement of farmers engaged in sustainable forestry practices is small. Enforcement of sustainable forestry practices is important for sustaining forest resources, yet development of effective policies and strategies to achieve them are problematic.

Currently, in Ghana, there are few or no incentives for farmers to engage in sustainable practices. Incentives are most of the time provided for only farmers engaged in cash crops such as cocoa.

2.10 PUBLIC PARTICIPATION IN FOREST MANAGEMENT

One of the core principles of Sustainable Forest Management (SFM) is that it reflects a diverse range of societal values in reference to forest conservation and use. The active and informed participation of communities and stakeholders affected by forest management decisions is critical to the credibility and sustainability of management processes (Owubah *et al.,* 2001). Public awareness creation and community sensitization play an important role in informing and educating the public, thereby allowing them to effectively participate in SFM decision-making (IUCN, 2010).

2.11 LAND COVER CHANGE DETECTION

Change detection according to Bruzzone and Cossu (2003), is the process of identifying differences in the state of an object or phenomenon by observing it at different times. There are five categories of causes that influence land-cover change. These are long- term natural changes in climatic conditions, geomorphologic and ecological processes such as soil

erosion and vegetation succession, human-induced alterations of vegetation cover and landscapes such as deforestation and land degradation, inter-annual climate variability and the greenhouse effect caused by human activities.

Modern technologies such as Remote Sensing and Geographic Information System (GIS) provide some of the most accurate means of measuring the extent and pattern of changes in landscape conditions over a period of time (Miller, A. B. Bryant, E.S. and Bernie, R.W. (1998). According to the IGBP/IHDP (1999), change detection studies seek to know the pattern of land cover change, processes of land use change and human response to land cover change.

Land cover change in Africa is currently increasing and causing widespread environmental problems and thus needs to be mapped (Ringrose, S. Vanderpost, C. and Maheson, W. (1997). This is important because the changing pattern reflects changing economic and social conditions. Monitoring of such changes is important for coordinated actions at the national and international levels (Bernard and Wilkinson, 1997).

CHAPTER THREE 3.0 MATERIALS AND METHODS

3.1 Study Area

The study area was the Chipa Forest Reserve. It lies in the South Eastern part of the Greater Accra Region of Ghana, in the Shai Osu Doku District. It is one of the four forest reserves in the Tema Forest District and one of the five forest reserves in the Greater Accra Forest Region of Ghana. The forest reserve has a total area of 23.04km^2. Chipa Forest Reserve lies within latitude 5^o 45' South and 6^o 05' North and longitude 0^o 05' East and 0^o 20' West (Figure 1). The study area has a woody stand (plantation stand and natural wood stand) of 47ha.

The reserve has seven fringe communities namely Kodiabe, Ayikuma, Gigedokum, Apese, Agomeda, Lawerkope, and Asebe. The people are Ga-Adangbes. Other ethnic groups such as Ewes and Krobos are also located. Farming food crops and rearing of animals such as goats and sheep are the main source of livelihood although some people are engaged in masonry, carpentry, hairdressing, teaching and trading.

The 2010 population census numbered the people of these communities to be 50,117 (Ghana Statistical Service Population Census (GSS), 2010) and they mostly occupied compound houses.

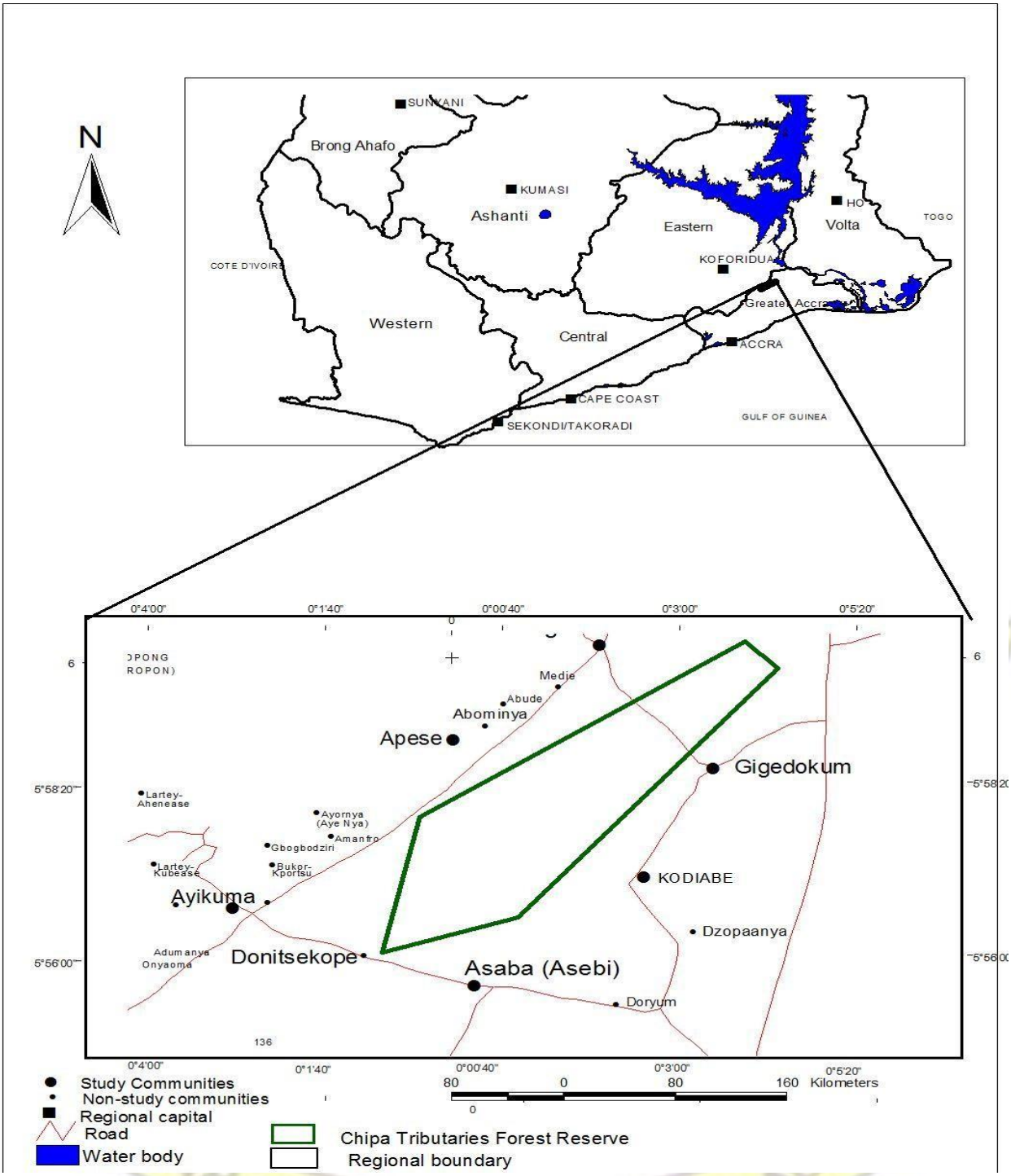


Plate 1: Map of Southern Ghana showing the location of Chipa Forest Reserve

Sources: Resource Management and Scientific Centre for Forestry Commission, Kumasi.Ghana

3.1.1 Climate

The study area falls within the coastal wooded savanna zone of Ghana. The mean annual rainfall is 28mm – 30mm with two peaks in June and October. There is a prolong dry season between November and May. According to the meteorological station at Dodowa, rainfall has been very irregular in recent times and this has resulted in drastic fall in agricultural production (Ghana Meteorological Agency, 2016).

The annual average temperature is 30^{o}C (GMet, 2016).

3.1.2 Flora and Fauna

The most common flora found in the area include, *Azadirachta indica* commonly known as the Neem tree, *Ceiba petandra, Khaya senegalensis, Talbotiella genti, Milletia thonningii, Diospyros abyssinica, Cassia siamea and Acacia spp.*

The common animal species include mammals such as grasscutter (*Thryonomys swinderianus*), baboons (*Papio spp*), fruit eating bats (*Epomops franqueti*), duikers (Bay duiker, and Yellow backed duiker) and reptiles such as green mamba (*Dendroaspis viridis*), Agama lizard (*Agama agama*). Birds species namely, Pied crow (*Corvus cornix*, and *Corvus albus*), Cattle egret (*Bubulcus ibis*), duck (*Cairina moschata*, and *Anas platyrhynchos*) domestic fowl (*Gallus gallus domesticus*), and guinea fowl (*Numida meleagris*) can be spotted in the area.

3.1.3 Topography

The area is generally low lying. The soil type in the area is the Savanna Greysol and Aluiosols (www.maphill.com/ghana).

3.1.4 Socio-economic status

The communities obtain regular supply of clean water from the Kpong water works located 3.20 km away. They are also connected to the national electricity grid. There are sixteen (16) primary schools and one Secondary school at Dodowa. The communities have good road networks linking them to Accra, Tema, Ashaiman, Larteh and Somanya.

3.2 Data Collection

3.2.1 Random sampling of trees commonly used as firewood.

Trees were grouped into small, medium and large sizes. Trees of diameters below 10cm (<10cm) were grouped as small. Those with diameters 10cm and above but less than 20cm (10cm ≤ 20cm) were grouped as medium and those with diameters above 20cm were grouped as large (≥20cm). Diameters of trees were taken from 1.3 m above ground or at breast height (dbh). Each one size of tree was felled to know the number of trees that will form a stere. A stere is equivalent to one cubic meter. This was done by placing sticks of length one (1) metre at a distance of one metre apart to form a cube (Plate 2 and 3).

Plate 2: Cutting of tree branches after selection using the tree diameter.

Plate 3: Packing harvested branches to form a stere (small tree).

Branches of felled trees were packed into the stere till it is filled up (see plate 4). This is one cubic metre.

The number of trees packed to form one cubic metre (one stere) provides an estimate of the number of trees that will be equivalent to one cubic metre (Plate 4 and 5). A stere is one cubic metre in volume.

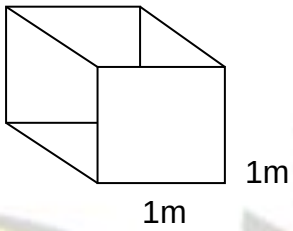
Plate 4: Packing harvested branches to form a stere (large tree).

Plate 5: Fully filled stere (large size tree)

Plate 6: Fully filled stere (small size tree)

3.2.2 Volume Estimation for a Bundle of Firewood.

A bundle of Neem firewood contains averagely six (6) Neem branches. It was estimated that, twenty-eight (28) bundles of Neem filled a stere. This was established by filling a stere (I cubic metre) with the bundles of firewood packed by the roadside for sale. In all, a total of twenty (28) bundles of firewood filled the stere.



A STERE (one cubic meter)

SMALIAN FORMULA FOR CALCULATING BOLE VOLUME

$$V = \pi L \frac{(DB^2 + DT^2)}{8}$$

Where V is Volume of a stem

DB is the Butt end Diameter

DT is the Tapper end Diameter

L is the Length of the Stem

Π is a constant which is 3.142

In order to estimate the volume of a bundle of firewood, ten (10) bundles were randomly picked from a stack of firewood ready for sales by the road side. Volumes of the branches that make up one bundle were calculated by using the Smalian formula (Affum-Baffoe K, Boakye J, and Obiaw E. (2011) and an average of the volumes of the branches were estimated. This provided an estimated volume of each bundle.

3.2.3 Questionnaire Administration.

Questionnaire was distributed to 20 families from the seven fringe communities and responses were gathered. This was done in the dry season since most firewood was collected during this period because of the dryness of the wood material.

Personal observation, interviews and semi-structured questionnaires were employed. The questionnaire was administered based on the willingness of people to provide information. The questionnaire focused on the size of family of the respondents, and their occupation. Also, information on the following was gathered;

- Sources of firewood
- Desirable species
- Quantities consumed in a week
- Commercial and domestic benefits of firewood collected.

3.2.4Statistical Analysis

Statistical tools such as Analysis of variance (ANOVA) were used to analyse responses from the questionnaire administered.

3.2.5 Problems associated with the data collection.

- Some of the respondents were not cooperative since they were not convinced of what their information was going to be used for.
- It was difficult to estimate the number of people who were involved in the firewood business since it was not a full-time occupation.
- Communication with respondents was difficult. Since they were Krobos, Ewes and Ga-Adangbes, translators were engaged to enhance the flow of communication.

CHAPTER FOUR

4.0 RESULTS

4.1 INTERVIEW RESPONSES

The survey was conducted in seven communities, namely, Asebe, Gigedokum, Kodiabe, Agomeda, Apese, Ayikuma and Lawerkope. In all, one hundred and forty (140) families were interviewed, specifically twenty (20) families from each community. Individuals in the family were interviewed to check consistency in responses.

4.1.1 Occupation Type

Table 1: Occupations of Inhabitants of the Study Communities.

Communities	**Farming**	**Teaching**	**Trading**	**Others**
Asebe	9	Nil	6	5
Apese	12	3	5	Nil
Agomeda	7	1	8	3
Gigedokum	9	3	3	7
Kodiabe	10	Nil	4	6
Ayikuma	12	5	2	Nil
Lawerkope	7	2	5	6
Total	**66**	**14**	**33**	**27**
%	**47**	**10**	**24**	**19**

Farming, trading and others stood out amongst the occupations registered in the communities (Table 1). Other occupation types recorded were hair dressing and beautician, taxi driving, plumbing and masonry. Farming recorded forty-seven percent (47%) of the

respondents. Twenty-four percent (24%)of the respondents were traders whereas ten percent (10%) were teaching and nineteen percent (19%) represented other occupations.

Apese and Ayikuma recorded the highest number of farmers. Agomeda recorded the least in teaching and Ayikuma recorded the highest in teaching. Agomeda recorded the highest in trading and Gigedokum recorded the highest in other occupations.

4.1.2 FAMILY SIZE DISTRIBUTION

Table 2: Family size distribution of individuals sampled in the communities.

Communities	**1-4**	**5-8**	**9-12**	**13-16**
Asebe	11	7	2	Nil
Apese	11	9	1	Nil
Agomeda	6	5	7	2
Gigedokum	5	10	3	1
Kodiabe	10	9	1	Nil
Ayikuma	7	6	5	2
Lawerkope	13	2	5	Nil
Total	**63**	**48**	**24**	**5**
%	**45**	**34**	**17**	**4**

According to the data in Table 2, Family size of 1-4 members recorded forty-five percent (45%), family size of 5-8 members recorded thirty-four percent (34%). Family size of 9-12 members recorded seventeen percent (17%) and 13-16 members recorded four percent (4%) of the total sample size of one hundred and forty (140) families. These families are all

resident in the community. They are permanent residents and not partial residents. They live mostly in family homes and compound houses. Only about five percent (5%) of interviewees lived in their own homes. Members of both nuclear and extended families were interviewed.

4.1.3 USE OF FIRE WOOD.

Table 3: Sampled population using firewood in the study communities

Communities	**YES**	**NO**
Asebe	20	NIL
Apese	20	NIL
Agomeda	20	NIL
Gigedokum	20	NIL
Kodiabe	20	NIL
Ayikuma	20	NIL
Lawerkope	20	NIL
Total	**140**	**NIL**
%	**100**	**0**

In table 3 above, all twenty (20) respondents from each of the seven (7) communities indicated that they used firewood. There was evidence of firewood usage on their compounds.

4.1.4 FIREWOOD CONSUMPTION IN A WEEK IN THE STUDY COMMUNITIES.

Responses from the interviewees indicated that quantities of firewood used for a week varied from one family to the other. Table 4 below gives an indication of quantities of firewood used. Thirty-seven percent (37%) of respondents used 1-5 bundles of firewood in a week, forty-four percent (44%) of respondents used 6-10, sixteen percent (16%) used 11-15 bundles and three percent (3%) used 15-20 bundles in a week.

Only one family in Asebe used 11-15 bundles of firewood in a week. Generally, most of the families appeared to use 6-10 bundles of firewood in a week. None of the families in Gigedokum consumed 11-15 bundles. Three families each in two communities namely Ayikuma and Agomeda consumed 11-15 bundles in a week. Lawerkope recorded the least number of families that consumed 6-10 bundles in a week and Agomeda recorded the least number of families that consumed 1-5 bundles in a week.

Only four families, one each in Lawerkope and Kodiabe and two in Agomeda, consumed 15-20 bundles of firewood in a week. None of the families in Asebe, Apese, Gigedokum and Ayikuma consumed 15-20 bundles of firewood. Most families in Asebe consumed 610 bundles of firewood, likewise most families in Ayikuma consumed 1-5 bundles of firewood (Table 4).

Table 4: Firewood bundles used in a week by the study communities.

Communities	**1-5 Bundles**	**6-10 Bundles**	**11-15 Bundles**	**15-20 Bundles**
Asebe	6	13	1	Nil
Apese	8	7	6	Nil

Agomeda	5	9	3	2
Gigedokum	9	11	Nil	Nil
Kodiabe	6	9	4	1
Ayikuma	10	7	3	Nil
Lawerkope	8	5	6	1
Total	**52**	**61**	**23**	**4**
%	**37**	**44**	**16**	**3**

4.1.5 TREE SPECIES USED AS FIREWOOD

Sixty-six percent (66%) of respondents used Neem tree (*Azadirachta indica*) as firewood, nine percent (9%) of respondents used *Cassia* spp and nineteen percent (19%) used *Acacia* spp. Five percent (5%) used other tree species (Table 5). The other tree species include Black berry tree, *Mangifera indica* (Mango tree) and Almond tree. Gigedokum appeared to be the community which mostly used Neem tree. This was followed by Kodiabe, Asebe and Agomeda. Lawerkope was the community that used *Acacia* most. She also recorded the least number of families that used Neem tree.

Table 5: Tree species used as Firewood in the Study Communities.

Communities	**Neem**	***Cassia***	***Acacia***	**Others**
Asebe	14	Nil	6	Nil
Apese	12	2	5	1

Agomeda	14	1	4	1
Gigedokum	16	1	2	1
Kodiabe	14	1	3	2
Ayikuma	13	7	Nil	Nil
Lawerkope	10	1	7	2
Total	**93**	**13**	**27**	**7**
%	**66.4**	**9.3**	**19.3**	**5**

Cassia is the least firewood species used in Gigedokum, Kodiabe, Agomeda and Lawerkope. Families in Ayikuma did not use *Acacia* and other tree species as firewood. Families in Asebe also did not use *Cassia* and other trees as firewood.

4.1.6 MOST SATISFYING TREE SPECIES AS FIREWOOD

In table 6, Neem tree was the most preferred tree species as eighty-three percent (83%) of respondents attested. Plate 7 provides a picture of small size neem tree. Five percent (5%) said *Cassia* was satisfying. Eleven percent (11%) of the respondents preferred *Acacia* and one percent (1%) of respondents indicated that they were satisfied with other species (Table 6).

Table 6: The most satisfying tree species for firewood.

Communities	**Neem**	***Cassia***	***Acacia***	**Others**
Asebe	17	Nil	3	Nil

Apese	18	2	Nil	Nil
Agomeda	16	Nil	4	Nil
Gigedokum	18	Nil	2	Nil
Kodiabe	15	5	Nil	Nil
Ayikuma	16	Nil	4	Nil
Lawerkope	16	Nil	3	1
Total	**116**	**7**	**16**	**1**
%	**83**	**5**	**11**	**1**

Apese and Gigedokum recorded the highest of the communities that mostly preferred Neem tree. Kodiabe recorded the least community that preferred Neem and the most number of families that preferred *Cassia*. *Acacia* was mostly preferred at Ayikuma and None of the families in Agomeda, Asebe, Gigedokum, Ayikuma and Lawerkope preferred *Cassi*a. Also, none of the families in Apese and Kodiabe preferred *Acacia.* Only one family in Lawerkope preferred other tree species.

Plate 7: Small size Neem tree plantation

4.1.7 LEAST SATISFYING TREE SPECIES

Out of the three less used tree species, *Cassia* was declared least satisfying. As shown in Table 7, sixty-nine percent (69%) of the respondents attested to this. Twenty-four percent (24%) said *Acacia* was least satisfying and seven percent (7%) said other tree species were least satisfying. Neem was the most satisfying. Ayikuma had most families saying that *Cassia* is least satisfying. However, Gigedokum and Kodiabe recorded the least number of families that said *Cassia* was least satisfying. Only Apese and Gigedokum recorded families that said the other tree species were least satisfying. One family in Apese said *Cassia* was least satisfying.

Table 7: Least satisfying tree species.

Communities	Neem	*Cassia*	*Acacia*	Others
Asebe	Nil	14	6	Nil
Apese	Nil	15	1	4
Agomeda	Nil	13	7	Nil
Gigedokum	Nil	12	3	5
Kodiabe	Nil	12	8	Nil
Ayikuma	Nil	18	2	Nil
Lawerkope	Nil	13	7	Nil
Total	**Nil**	**97**	**34**	**9**
%	**0**	**69.3**	**24.3**	**6.4**

4.1.8 SOURCES OF FIREWOOD

Firewood was collected from the Forest Reserve, people's farms, off the forest reserve (bushes) and backyard. In table 8, Forty-nine percent (49%) of respondents collected firewood from the forest reserve and twenty percent (20%) from bushes. Twenty-five percent (25%) of the families collected firewood from farms and six percent (6%) from the backyard.

Agomeda recorded the highest community that collected firewood from the reserve whereas Gigedokum recorded the least. Gigedokum was the community that had most families collecting from bushes. Kodiabe recorded the highest for families that collected

firewood from farms. Lawerkope recorded the highest number of families that collected firewood from backyards also Lawerkope recorded the least number of families that collected firewood from their farms.

Lawerkope recorded the least number of families that collected firewood from farms. One family each in Asebe and Gigedokum collected firewood from their backyards. Plate 8 shows a large Neem tree at a backyard.

Table 8: Sources of firewood for the study communities.

Communities	**BUSH**	**FOREST**	**FARMS**	**BACKYARD**
Asebe	4	10	5	1
Apese	6	8	6	Nil
Agomeda	2	13	5	Nil
Gigedokum	8	7	4	1
Kodiabe	2	10	8	Nil
Ayikuma	5	11	4	Nil
Lawerkope	1	10	3	6
Total	**28**	**69**	**35**	**8**
%	**20**	**49**	**25**	**6**

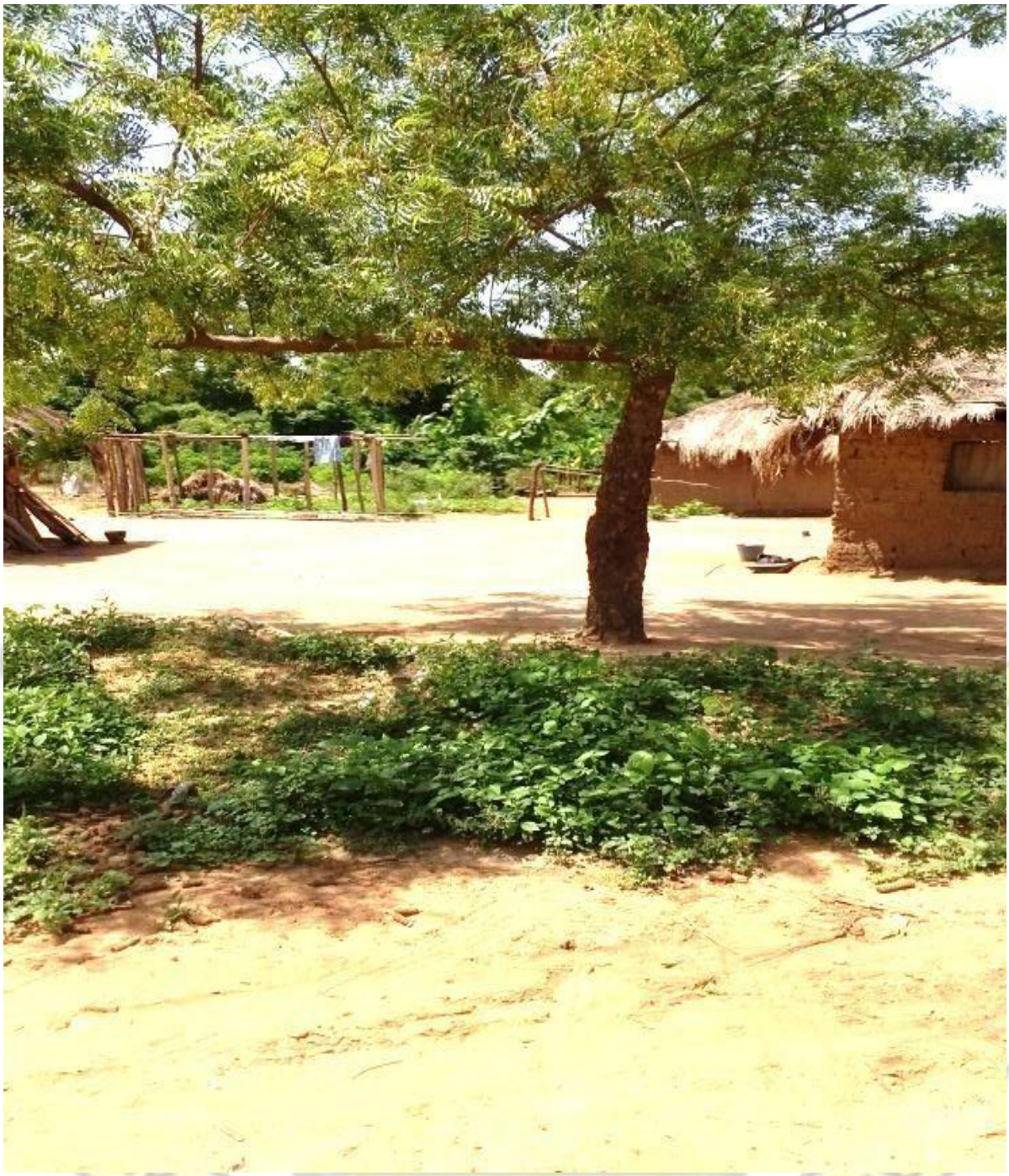


Plate 8: Neem tree located in a back yard.

4.1.9 ACCESS TO FIREWOOD

Accessibility to firewood is reflected in Table 9. Sixty-six percent (66%) of respondents said they easily located firewood and thirty-four percent (34%) said they did not. Kodiabe community recorded the highest number of families that could access firewood easily. They were followed by Apese and Gigedokum. However, Lawerkope and Asebe recorded the least number of families that could access firewood. Inferably Lawerkope and Asebe recorded the highest number of families that could not access firewood easily.

Table 9: The accessibility to firewood

Communities	**YES**	**NO**
Asebe	11	9
Apese	15	5
Agomeda	13	7
Gigedokum	15	5
Kodiabe	16	4
Ayikuma	12	8
Lawerkope	11	9
Total	**93**	**47**
%	**66**	**34**

4.1.10 DISTANCE COVERED TO FETCH FIREWOOD

Forty-four percent (44%) of the families travelled for just a kilometre to locate firewood.

Thirty-one percent (31%) of respondents travelled about two (2) kilometres, twenty-two percent (22%) travelled three (3) kilometres and three percent (3%) travelled as far as four (4) kilometres and beyond to locate firewood. Ayikuma recorded the highest number of families that fetch firewood within a kilometre.

Table 10: Distances covered to fetch firewood.

Communities	**1 km**	**2 km**	**3 km**	**4 km**
Asebe	5	8	7	Nil
Apese	5	9	6	Nil
Agomeda	11	9	Nil	Nil
Gigedokum	12	5	3	Nil
Kodiabe	9	4	7	Nil
Ayikuma	16	4	Nil	Nil
Lawerkope	3	5	8	4
Total	**61**	**44**	**31**	**4**
%	**44**	**31**	**22**	**3**

This is followed by Gigedokum and Agomeda. Lawerkope alone recorded families that travel 4 kilometres to fetch firewood. There was no family in Agomeda and Ayikuma who fetched firewood within 3 or 4 kilometres.

4.1.11 MOST EASILY LOCATED TREE SPECIES

Table 11: Firewood tree species easily located in the communities.

Communities	**Neem**	***Cassia***	***Acacia***	**Others**
Asebe	19	Nil	1	Nil
Apese	17	3	Nil	Nil
Agomeda	15	3	2	Nil
Gigedokum	20	Nil	Nil	Nil
Kodiabe	18	1	1	Nil
Ayikuma	18	2	Nil	Nil
Lawerkope	14	Nil	6	Nil
Total	**121**	**9**	**10**	**Nil**
%	**86.5**	**6.5**	**7**	**0**

Neem is the most easily located tree species as eighty-six percent (86%) of respondents attested to this. This was followed by *Acacia* with seven percent (7%) and *Cassia* also with about seven percent (6.5%). Table 11 provides the details. The communities indicated that, it was not easy to locate dead branches of the other trees like *Mangifera Indica, Rubus fruticosus*, and *P. dulcis*. Gigedokum community recorded the highest number of families that located Neem tree easily as Lawerkope recorded the least. *Cassia* was mostly located by Apese and Agomeda communities. Families in Gigedokum and Lawerkope do not locate *Cassia,* whilst families in Gigedokum and Ayikuma do not locate *Acacia.*

4.1.12 FREQUENCY OF FETCHING FIREWOOD

Table 12: Frequency of fetching firewood.

Communities	Daily	Weekly	Bi-weekly	Monthly
Asebe	7	10	3	Nil
Apese	7	13	Nil	Nil
Agomeda	6	2	12	Nil
Gigedokum	6	10	1	3
Kodiabe	4	14	2	Nil
Ayikuma	9	7	3	1
Lawerkope	4	7	8	1
Total	**43**	**63**	**30**	**5**
%	**31**	**45**	**21**	**3**

In table 12 above, Thirty-one percent (31%) of respondents collected firewood daily. Forty-five percent (45%) collected firewood weekly, twenty-one percent (21%) of them collected firewood bi-weekly, and three percent (3%) of the families also collected firewood monthly. Most families in Kodiabe collected firewood weekly. Agomeda stood out in families who collected firewood bi-weekly. Most families in Ayikuma collected firewood daily. Kodiabe and Lawerkope recorded the least number of families that collected firewood daily whereas Apese and Asebe followed Ayikuma. Gigedokum recorded the highest number of families that collected firewood monthly. Agomedan, Apese, Asebe and Kodiabe did not record any family which collected firewood monthly.

4.1.13 FIREWOOD AS A SOURCE OF LIVELIHOOD

Table 13: Firewood collection as a source of livelihood.

Communities	**YES**	**NO**
Asebe	8	12
Apese	9	11
Agomeda	5	15
Gigedokum	13	7
Kodiabe	17	3
Ayikuma	14	6
Lawerkope	5	15
Total	**71**	**69**
%	**51**	**49**

Fifty-one percent (51%) of the 140 families indicated that they made earnings from selling firewood and forty-nine percent (49%) said they did not make earnings from firewood. Kodiabe recorded the highest number of families that made earnings from firewood, they were followed by Ayikuma and Gigedokum. Lawerkope and Agomeda recorded the least. Agomeda and Lawerkope recorded the highest number of families who did not make earnings from firewood. Kodiabe recorded the least number of families who did not make earnings firewood.

4.1.14 INCOME FROM FIREWOOD IN CEDIS

Table 14: Firewood income made in a month (GHC).

Communities	**50**	**100**	**150**	**200**
Asebe	3	2	3	NIL
Apese	4	3	2	Nil
Agomeda	1	1	3	Nil
Gigedokum	3	8	2	Nil
Kodiabe	7	6	3	1
Ayikuma	2	5	7	Nil
Lawerkope	Nil	2	2	1
Total	**20**	**27**	**22**	**2**
%	**28**	**38**	**31**	**3**

Out of the one hundred and forty (140) families, only seventy-one (71) indicated that they made earnings from the firewood they collected. Twenty-eight percent (28%) of the seventy-one (71) respondents made GHC 50.00 in a month. Thirty-eight percent (38%) made GHC100.00, thirty-one percent (31%) make GHC 150.00 and only three percent (3%) made GHC 200.00 in a month. This indicates that, should the families make it a core duty to trade in firewood; they could actualise substantial gains to support their families. Kodiabe recorded the highest to gain GHC 50.00 in a month. Also, a family each Lawerkope and Kodiabe recorded earnings of GHC 200.00 in a month. Ayikuma recorded the highest

number of families that earned GHC 150.00. Gigedokum recorded the highest number of families that earned GHC 100.00 and Agomeda recorded the least.

4.2 VOLUME ESTIMATION OF FIREWOOD.

4.2.1 Volume Estimation as used in Forest Services Division (FSD).

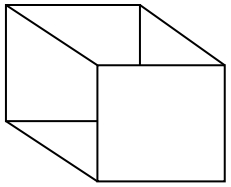
Neem Tree	No. of trees that formed a stere
Small sized trees	5
Medium sized trees	3
Large sized trees	2/3

Averagely, branches from five (5) small Neem trees completed a stere which is equivalent to one cubic metre volume of Neem tree. Three medium size Neem tree branches filled a stere to produce a one cubic metre volume of Neem tree. Branches from 2/3 large size Neem trees produced one stere (one cubic metre) of Neem tree.

4.2.2 Volume Estimation for a Stere of Neem Tree.

It was estimated that, twenty-eight (28) bundles of Neem filled a stere. This was established by filling a stere (I cubic metre) with the bundles of firewood packed by the roadside for sale. In all, a total of twenty (28) bundles of firewood filled the stere.

1m **A STERE** (one cubic meter)



4.2.3 Estimation of a Bundle of Firewood.

In order to estimate the volume of a bundle of firewood, ten (10) bundles were randomly picked from a stack of firewood ready for sales by the road side. Volumes of the branches that make up one bundle were calculated and an average of the volumes of the branches was estimated. This provided an estimated volume of each bundle.

Consequently, an average volume was estimated for the ten (10) randomly selected bundles and this represented the volume of a bundle of firewood.

Table 4.2.3 Average volume of a bundle of firewood

Bundle No.	Volume (m^3)
1	0.034
2	0.046
3	0.023
4	0.031
5	0.045
6	0.041
7	0.037
8	0.037
9	0.035

10	0.032
Total	**0.356**

Average volume = $\frac{\text{Total sum of volume of bundles}}{\text{Total number of bundles}} = \frac{0.356}{10} = 0.0356m^3$

Average volume per bundle = 0.0356 approx**. 0.036 m^3**

Since, it was realised that twenty-eight (28) bundles filled up a stere and an estimated volume of a bundle was found to be 0.036m^3, the volume of a stere was estimated.

28 bundles = 1 stere

If the volume of a bundle is 0.036m^3, then the volume of a stere

28 * 0.036 = 1.008m^3 approximately 1m^3

CHAPTER FIVE

5.0 DISCUSSION

5.1 OCCUPATION

The questionnaire responses showed that although the population of the fringe communities indulged in other occupation such as farming, masonry, hairdressing, trading and teaching, almost everybody harvested firewood. Occupation type was recorded for only family heads. Some of the families had females being their head, that is to say; it's a mother, an auntie or a grandmother. Occupation of interviewee was confirmed by members of the family or a community member. Firewood was their main source of fuel. Few families, however, harvested to sell as their source of livelihood.

This affirmed the statement by A. V. Korotkov and T. J. Peck (1993) that, forests constitute a very important part of the immediate surroundings of the rural poor in developing countries and provided their main source of fuel.

The forest stands provide both productive and protective functions and contributed immensely to the economy of the rural community.

5.2 PREFERED TREE SPECIES

Fuel woods were obtained from various species of trees. However, *Cassia spp, Acacia spp*, *Azadirachta indica*, *Mangifera indica*, *Rubus fruticosus* and *Prunus dulcis* (Almond tree) were the major trees that were harvested for firewood. The most harvested tree was *Azadirachta indica* (Neem). Respondents indicated that Neem could easily be located as it was the dominant species in the area. Neem thrived well in the community because of the existing vegetation and soil type. Neem matures in a span of 3 years when tended properly (neemfoundation.org). The tree, when dry catches fire easily and ashes slowly hence the most preferred tree species. This has put pressure on the forest reserve. Should the Forest Services Division of Ghana attempt providing the fuel needs of the people seriously, Neem could be planted in the reserve and if managed properly, could provide firewood for the community, enough for consumption and for conservation as well.

A hectare of forest land takes one thousand, one hundred and eleven (1,111) Neem trees (FSD, Plantation Annual Report, 2011). The entire reserve could be compartmentalized. That is to say the reserve could be divided into 128ha plots and as estimated in chapter 4, three (3) medium size Neem trees make a one volume which is also a stere (one cubic metre) of Neem tree. Indicating that 370.333 m^3 of Neem can be extracted from a hectare of Neem plantation.

5.3 FIREWOOD CONSUMPTION

FAO (1983, 1984) estimated that for coastal wooded savanna, the annual firewood consumption per person is 2.01m^3 whiles FAO (1984) stated that in terms of rural population alone annual firewood consumption for such areas is 1.9m^3 per person.

Firewood therefore is a need in the lifestyle of all the people in the seven communities. It seems the communities are not aware of LPG or they are unable to afford it. Cooking cannot be done in a compound when there is shortage of firewood. This affects large family houses where food is cooked for all family members: in-laws, nephews, nieces, brothers, sisters and grandchildren. Thus, firewood is fetched in larger quantities in such homes.

According to the respondents, Neem is a hardwood and takes a longer time to burn into ashes. Also, setting fire to Neem is not difficult. Although most people admitted Neem was a good source of firewood some people also indicated that when a mango tree grows very old it develops very dense sapwood which burns for a long time. Some claimed they sometimes split much matured mango trees into lumber. The staff of FSD indicated that, Neem matures fully in five years but can be harvested for firewood in three years although in both young and matured stages parts of the tree such as the bark, roots, leaves and branches are harvested for medicine. According to the community folk, they referred to Neem as the 'wonder tree'. On the other hand, *Cassia* burns faster and both *Cassia* and *Acacia* are evergreen all year. They also serve as foliage for goats.

A critical analysis of Table 4 indicates that families fetch firewood, daily, weekly or monthly. A total of 1,295 bundles of firewood are estimated to be used weekly by the respondents.

This is equivalent to 46.620 m^3 per week. Estimating this proportionally for a month is 202.02m^3 and a total of 2,424.240m^3 annually by the 140 families interviewed.

If 1 bundle = 0.036, then 1,295 will be

1,295 * 0.036 = 46.620m^3

Volume of firewood used for a week = 46.620m^3

*This therefore implies that, the total volume for a **MONTH** will be:*

*4 weeks * 46.62 = **186.480m^3***

*And for a **YEAR** will be 52 weeks * 46.62* ***= 2,424.240m^3 for 140 families***

5.4 SOURCES OF FIREWOOD

Firewood was collected from farms, bushes, homes or backyard and mostly from the Chipa Forest Reserve. This has resulted in the decline in the area of the Forest Reserve and thus indicating the high need for firewood. The Forest resource would keep dwindling if measures are not taken to meet the demand for firewood.

Forest guards manning the reserve indicated that, the area was too big for them. According to them, their numbers do not match up with the load of work. Also, the communities find

their way into the reserve mostly on weekends when they were away. Some explained that since their working beat spanned 10 km, they were not always at a particular place.

Most families had Neem trees in their backyard. Some had the tree planted in the middle of the house to provide shade and an afternoon resting place. Some families indicated that they needed not plant Neem trees since the tree shoots up on the compound whenever there is rain. They indicated that, it was the only tree species anybody in the community could obtain its saplings in large quantity and cultivate. Neem tree needed less attention to grow and can withstand very harsh weather conditions.

In spite of the dry and unfertile nature of the soil in the study area, neem tree thrived better in comparison to the other species. The roots penetrate the soil deeply; at least as far as possible and when injured, the tree produces suckers. This suckering tends to be especially prolific in dry localities (www.discoverneem.com). Neem tree is able to endure considerable abuse. It easily withstands pollarding and its topped trunk re-sprouts vigorously and it also freely coppices (FSD, Plantation Annual Report 2011). Re-growth from both pollarding and coppicing can be exceptionally fast because it is supported by a matured stem and root system.

5.5 AVAILABILITY OF FIREWOOD

Farms and Forest reserves continue to provide the communities with the bulk of firewood. The Neem tree was seen to be the most dominant tree species within the communities.

There was evidence of plantations of neem tree undertaken by the Forest Services Division in the Forest Reserve. The Chipa Forest Reserve seems to be under stress since the dominated tree species is overly exploited. The dominance of the Neem tree in this area gives reasons as to why it is most preferred apart from its burning attributes. The Neem tree can be located in farms, fallow lands and at the back yards of most homes. The germination ability of the seeds is very high (www.discoverneem.com). The rate of sprout indicates how viable the seeds are.

The Chipa Forest Reserve currently, has a woody stand of 47 ha. A planting distance of 3 m * 3 m which is the standard for woodlots will produce 1,111 trees for every hector of land. This implies that the 47 ha will produce 52,217 trees. By the estimation in chapter 4, five (5) small trees were established to form a volume of firewood. This therefore indicates that the 52,217 trees will produce an equivalent volume of 10,443.400 m^3. It was also established that, in a year, the 140 families consume 2,424.240 m^3 of firewood. This explains that, the current wood stand in the forest reserve will be able to provide the firewood needs for the community for only 55 months (4.7 years).

The forest reserve has a total forest cover of 23.04km^2 which is approx. 2,304 ha

Should a plantation be established on the 2,304 ha, 2,559,744 trees will be established since 1 ha produces 1,111 (FSD Plantations MOP)

Using 5 small size trees = 1 m^3

2,559,744 trees = 511,949.000 m^3

then *511,949.000 / 2,424.240 m^3 = 211 years*

If Cost of a volume of firewood is GHC 28.00, the total volume of 511,949 will be

GHC 28 * 511,949m3 = GHC 14,334,572.00

The rate at which fuel wood is collected from these lands is higher than the rate at which the fuelwood tree grows. Natural regeneration is very poor. According to most of the respondents, they prefer collecting firewood weekly because of their day to day activities. Most of the collection was done by the children in the family and since they were school children, the collection was done mostly in the early mornings and on Saturdays and Sundays. They were not also disturbed by forest guards on weekends. Although they collected some firewood from the off-reserve, most of the firewood was felled within the forest reserve.

FAO (2010) indicated that such natural stands, if properly managed, could produce between 30m^3 to 75m^3 per hectare. This clearly depicts that artificial stands or plantations in such areas could produce more than 75m^3 per hectare. The Forestry Commission of Ghana has clearly stated that one hectare of savanna land could produce 1,111 stands of Neem when properly managed (Forestry Commission, 2003).

Farm lands do not provide a continuous source of firewood because once the wood is collected during land preparation; nothing is obtained again until the area goes fallow for

about 2-4 years (www.aces.uiuc.edu). Mechanised land preparation is the most common farming system practised in these communities. For this reason, in the first year of the fallow period, herbaceous wood growth is profuse (www.aces.uiuc.edu). It takes 2 years before woody plants, mostly Neem begin to appear (www.aces.uiuc.edu).

In farmlands and bushes, seeds are distributed through cattle faeces as cattle feed on the Neem tree. Tending operations are totally absent since the farmers neglect their farms. The crowded stand soon leads to intense competition for light and nutrients and wild bush fires, which are very frequent during the dry season. Apart from killing a lot of the seedlings, retarded growth sets in (www.discoverneem.com). When asked why they preferred the forest, respondents indicated that it was easier locating firewood in the forest, as the forest had a lot of trees compared to the farm and the off-reserve.

Our daily activities as human beings have indeed affected and stressed out the natural resources around us. This has gradually depleted firewood resources since there has not been a proper strategy to address the sustainability of the resource. Many people believe that our forest reserves need to be walled and be under lock.

5.6 FIREWOOD AS A SOURCE OF LIVELIHOOD

The methods adopted for harvesting commercial firewood particularly those that do not receive any tending operations are peculiar to Ghana since it is the same mechanical harvesting with cutlass, and mattock with cutlasses at heights ranging from some few centimetres to about two (2) metres above ground level. Both small and large trees are

clear felled (harvesting all trees available). Some of the firewood collected is used domestically and some are sold out for money.

According to Trossero (2002), the bulk of fuel wood amounting to 90% is obtained directly from the natural forest. The remaining10% is from wood waste, illegal logging and sawmill residue and plantation forests. The transition and savanna zones of Ghana, mainly Kintampo, Nkoranza, Wenchi, and Afram plains provide the bulk of firewood. However, in the high forest zone, firewood resources are depleting at a faster rate (Gyasi et al; 1995).

5.7 Firewood Trading

It is often said that when demand increases, supply must increase to make up for the demand (Mensah, 2011). Demand for firewood keeps increasing as the years go by and as population grows. Ghana introduced Liquefied petroleum gas to be used for cooking both in homes and in factories in an attempt to reduce the use of firewood (Mensah, 2011). This directive turned out to be a fallacy as demand for firewood keeps increasing. Most people are unable to afford the cost of LPG. Most of those who collect firewood for sale by are doing so as a source of livelihood.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 CONCLUSIONS

6.1.1 FIREWOOD AS A RESOURCE

Firewood has become a basic necessity in Ghana more than ever. Communities living around a source of firewood seem unable to survive without firewood. Over two (2) million Ghanaians depend on the forest to survive. In spite of several millions of foreign exchanges being spent to save the forest, Ghana continues to lose its green zone (Gyasi et al; 1995) the total annual consumption for the country was about 700,000 tonnes and 30% of this was consumed in the capital, Accra (Mensah, 2011). The total firewood consumed by the household sector was about 11 million tonnes of oil equivalent in 2000 and it rose to about 13 million in 2003 (Energy Commission, 2006). Fuelwood, apart from being used for domestic cooking is also used for other commercial ventures including bread bakeries in the country (Mensah, 2011).

The inhabitants of the study communities obtain firewood from their own farms, the Chipa Forest reserve, their back yards and secondary off-reserves. If the harvesting of firewood from all these sources is not regulated and managed properly, there will be a situation whereby firewood would be hard to find. Indiscriminate felling of trees for firewood to either sell or use domestically is predominant among rural dwellers and this is a major contributing factor eating up the forests of Ghana. Staggering figures made available from the UN outfit, Food and Agriculture Organisation, (2000) showed that about 69% of all urban households in Ghana use firewood for cooking and heating. The annual per capita consumption is around 1,800kg (Mensah, 2011).

6.1.2 GATHERING FIREWOOD AS A BUSINESS

Firewood for sale is usually sent to the urban areas. The local people collect firewood and pack them along the main road to Accra. The middlemen in firewood business buy the firewood and sell them in the urban areas. A bundle of firewood from the local people is sold at GHC 1.00; it is sold in the urban cities at GHC 2.0 or GHC 2.50 depending on the location. This implies that a stere of firewood will be sold at GHC 28.00. This can help improve the livelihood of members of the community.

A bundle of firewood is sold at GHC 1.00

If 28 bundles form a stere (1mx1mx1m),

Then, a stere will cost 28 x1 = GHC 28.00

This further explains that a volume of firewood will cost GHC 28.00

6.1.3 MANAGEMENT OF FIREWOOD AS A RESOURCE

The study showed that currently firewood is in high demand and firewood is easily located. This situation can only be stabilized if proper management of the resource base is put in place. Firewood from the off-reserve can only be managed by sensitizing the community on how to harvest firewood and ensure the replacement of the harvested resource.

Firewood in the forest reserve can be managed since the Forest Services Division (FSD) is mandated to manage the resources in the forest reserve. FSD is well vexed in silvicultural practises that can support trees for firewood. Trials in planting these trees have been carried out and plantations of these trees can be established to support firewood production. With the help of the Tema District Office of FSD, 1,111 trees can be established on a hectare of land (FC, 2003). This means that, taking the total area of the Chipa Forest Reserve which is about 2,304 ha, 2,559,744 trees can be established. This, when well-managed, can meet the community demand, and since proper silvicultural practices are put in place the harvested trees can coppice and mature within three years to continue the cycle (en.howtopedia.org (2015)).

6.1.4 PREFERED TREE SPECIES FOR FIREWOOD

Neem tree (*Azachirachta indica*) was the most preferred tree species, although *Acacia* spp and *Cassia* spp were found to be next in preference. Trees such as *Mangifera indica*,

Prunus dulcis, and Almond were also used as firewood. These trees were selected on their ability to catch fire, how fast they burn, and the quantity of ash produced after burning.

Neem tree > *Acacia* spp > *Cassia* spp > Others

Due to this the direction of the arrow shows the order of preference for the wood species.

As a result of its preference the Neem tree seems to be getting depleted as compared to the other species. This has resulted in the establishment of about 25 hectares of Neem tree (FSD, 2013). The management of this plantation is not encouraging as proper tending of this plantation cannot be afforded by the FSD since the Division survives only on government subvention. Also beating up (replacement for dead seedlings) and fluctuations in the rainfall pattern in the District has not supported the growth of trees. Financial resources for establishing and maintaining the plantations are secured before the establishment of plantations. Furthermore, community members are not sensitized to establish their own woodlots to support the resource produced by the forest.

6.2 RECOMMENDATIONS

On the basis of the findings in the current study, the following recommendations are made:

- There is the need to encourage people to undertake woodlot plantations.
- The Forestry commission should also intensify the establishment of plantations in the Chipa Forest Reserve.

- Planting of trees should be part of our lives as a people. Firewood production should be managed under proper silvicultural practices and management prescriptions (Mensah, 2011).
- People in the firewood business should also be made to know that firewood can be produced by planting trees themselves. Firewood dealers should start planting trees on available lands within their enclave. They should understand that they cannot continue to depend on natural occurring stands only, for their business.
- The FC of Ghana and the Environmental Protection Agency, Ghana, should be made to implement the policy of replacing trees when they are felled. This should be disseminated to Chiefs, Unit Committees and the District Assemblies to implement, since they are very close to the resource and are also beneficiaries of the resource. This policy can also be incorporated in the bye-laws of the District Assembly. With that legal backing, people will respect it. Until laws are enforced, indiscriminate felling of trees for firewood will not stop.
- Conscious sensitization from the primary school will build up an attitude within people as they grow. The more people are thought about the importance of their surroundings, the higher priority they put on the appearance of their surroundings.
- Tree planting clubs could be established in schools in the communities. These clubs are to always make their presence felt in the schools. This could build their interest in tree planting. Non-Governmental Organisations (NGOs)should always visit schools and support environmental clubs.
- Education on the importance of the existence of high volume tree stand in the nation should be highlighted.

- The media should be extensively involved in the propagation of planting trees and halting indiscriminate felling of trees. The importance of trees both tangible and intangible should be made known to the public. The awareness creation and the enlightenment will make people think otherwise and begin to show some concern, interest and appreciation for trees.
- Currently, law enforcement thrives in the world only when there is a presidential backing (www.thepoliticalinsider.com, 2016) Should the president of the nation Ghana publicly support the need for growing of trees, most people in the nation will buy the idea. Law enforcement agencies like the Forestry Commission, the Police Service, the Immigration Service, and the Judiciary Service should deal with issues pertaining to tree resources to the letter when cases are brought to their door step.

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APPENDIX

ANALYSIS OF VARIANCE ON RESPONSES FROM QUESTIONNAIRE

1.0 Purposes of the firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Domestic	63	44.7	45.0	45.0
	Commercial	33	23.4	23.6	68.6
	Both	44	31.2	31.4	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

1. Least satisfying tree species used as firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cassia	58	41.1	41.4	41.4
	Acasia	60	42.6	42.9	84.3
	Others	22	15.6	15.7	100.0
	Total	140	99.3	100.0	

Missing	System	1	.7		
Total		141	100.0		

2. Sources of the firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Forest	63	44.7	45.0	45.0
	Farm	48	34.0	34.3	79.3
	Bushes	23	16.3	16.4	95.7
	Others	6	4.3	4.3	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

3. Family size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-4	62	44.0	44.3	44.3
	5-8	49	34.8	35.0	79.3
	9-12	24	17.0	17.1	96.4
	13-16	5	3.5	3.6	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

4. Response on firewood usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	134	95.0	95.7	95.7
	No	6	4.3	4.3	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		

Total		141	100.0		

5. Quantity of firewood used weekly

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5 bundles	50	35.5	35.7	35.7
	6-10 bundles	64	45.4	45.7	81.4
	11-15 bundles	22	15.6	15.7	97.1
	16-20 bundles	4	2.8	2.9	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

6. Most satisfying tree species used as firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neem	116	82.3	82.9	82.9
	Cassia	3	2.1	2.1	85.0
	Acasia	20	14.2	14.3	99.3
	Others	1	.7	.7	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

7. Rate of firewood usage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	41	29.1	29.3	29.3
	Weekly	67	47.5	47.9	77.1
	Biweekly	31	22.0	22.1	99.3
	Monthly	1	.7	.7	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

8. Easy access to firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	95	67.4	67.9	67.9
	No	45	31.9	32.1	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

9. Most common tree species used as firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neem	121	85.8	86.4	86.4

	Cassia	9	6.4	6.4	92.9
	Acasia	10	7.1	7.1	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

10. Proximity of firewood source

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-1 mile	62	44.0	44.3	44.3
	2 mills	41	29.1	29.3	73.6
	3 miles	37	26.2	26.4	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

11. Firewood as a source of livelihood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	59	41.8	42.1	42.1
	No	81	57.4	57.9	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

12. Is income enough to support family

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	65	46.1	46.4	46.4
	No	75	53.2	53.6	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

13. Response on income accrued on monthly bases

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	50	63	44.7	45.0	45.0
	100	50	35.5	35.7	80.7
	150	25	17.7	17.9	98.6
	200	2	1.4	1.4	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		

14. Purposes of the firewood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Domestic	63	44.7	45.0	45.0
	Commercial	33	23.4	23.6	68.6
	Both	44	31.2	31.4	100.0
	Total	140	99.3	100.0	
Missing	System	1	.7		
Total		141	100.0		