CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Forestry and Wood Sciences

Department of Forest Technology and Construction

Operation of Ghanaian forest plantations and their effects on the local communities

BACHELOR'S THESIS

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Supervisor:

Ing. Martin Jankovský,

Author:

PhD. Prince Opoku Peseu

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Forestry and Wood Sciences

BACHELOR THESIS ASSIGNMENT

Dipl.-Ök. Prince Opoku Peseu

Forestry
Forestry

Thesis title

Operation of Ghanaian forest plantations and their effects on the local communities

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Objectives of thesis

To conduct a review of available knowledge on the economic, social, and other effects of forest plantations on Ghanaian locals.

Methodology

Within the proposed thesis, the student shall conduct a review of the current literature and other information sources on the state of forest plantations in Ghana and their social and economic impacts on the local communities. He shall focus on the planting, tending, and harvesting practices employed in Ghana to manage forest plantations and the way these practices affect the local communities. The effects should be considered in terms of economic and other benefits reaped by the local communities from the plantations and compared with the environmental and social costs for locals that result from operating forest plantations.

A review of current knowledge should be based on researching available literature sources, such as web of knowledge, SCOPUS, Google Scholar, as well as the databases of FAO, REDD+ program, UNFCCC, etc.

The proposed extent of the thesis

30

Keywords

forest plantations; harvesting technology; planting technology; plantation operation

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Recommended information sources

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The Bachelor Thesis Supervisor

Ing. Martin Jankovský, PhD.

Supervising department

Department of Forest Technologies and Constructions

Advisor of thesis

doc. Ing. Miroslav Hájek, Ph.D.

Electronic approval: 22. 9. 2018

doc. Ing. Miroslav Hájek, Ph.D.

Head of department

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prof. Ing. Marek Turčáni, PhD.

Dean

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Declaration

This thesis, Operation of Ghanaian forest plantations and their effects on the local communities was prepared by Opoku Peseu Prince to the Faculty of Forestry and Wood Science. The texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to citation rules of the FFWS.

Prague, April 2020

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Prince Opoku Peseu

Dedication

I dedicate this work to my supervisor Ing. Martin Jankovský, PhD, my parents, my siblings and all my friends who encouraged and inspired me in this study.

Acknowledgement

I wish to express my profound gratitude to the Almighty God, the Alpha and Omega for His endless love, kindness and protection throughout my studies and stay on campus. My profound gratitude also goes to my supervisor, Ing. Martin Jankovský, PhD. a lecturer at Faculty of Forestry and Wood Sciences at Czech University of Life Sciences, Prague. As my supervisor, he patiently corrected the draft of the work and enabled me to benefit from his vast experience. His comments, suggestions and constructive criticism were of great help to me. I am also grateful to my father, Mr. John Akwasi Peseu and to Madam Comfort Gyau, my mother for their financial support. I acknowledge the inevitable financial support of my brother Osei Bonsu Peseo and all my dear siblings. Finally, much thanks to all my friends who have been with me especially Ing.Isaac Nyarko, Ph.D. student with their advice, support and prayers. I say God bless you all.

Abstract

The continuous decline in Ghana's forest resources has resulted in an increased awareness by all stakeholders of the need to establish plantations to support resources already being sourced from natural forests. Currently, the alarming rate of Ghana's deforestation had negative socio-economic impacts on the country. The government, through the Forest Services Division, has therefore taken steps to remedy the situation through National afforestation and reforestation projects. This work was aimed to compile and review available scientific literature on operation of Ghana's forest plantations and effects on the local communities. This thesis was conducted to provide current information on the socio-economic and other impacts of forest plantations on the local communities in Ghana. The study concentrated on the plantation development in Ghana, some selected species, site for selection and their requirement were discussed. The study also looked at the management and harvesting practices at forest plantations in Ghana. Plantation development at the local communities in Ghana, however, needs proper guidelines to eradicate its negative impacts, and to fulfil its purpose to be achieved to ensure sustainable development of the natural resources in the country.

Keywords: Stakeholders, afforestation, reforestation, sustainable, socio-economic, livelihood, plantation

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List of abbreviations

NFPDP	National Forest Plantation Development Programme
FAO	Food and Agriculture Organization
TSDF	Tropical Semi-Deciduous Forest
GDP	Gross Domestic Product
HFZ	High Forest Zone
RMSC	Resource Management Support Centre
PD	Plantations Development
FSD	Forest Services Department
MTS	Modified Taungya System
AFDB	Africa Development Bank
CFMP	Community Forestry Management Project
SRA	Social Responsibility Agreement
GPDP	Ghana Plantation Development Programme
AAC	Annual Allowance Cut
FBPA	Forest-Based Poverty Alleviation
HFBCA	High Forest Biodiversity Conservation Areas
FST	Forest Savanna Transition
SF	Savanna Forest
FC	Forestry Commission
REDD	Reducing emission from deforestation and forest degradation
HIPC	Highly Indebted Poor Country
FLEGT	Forest Law Enforcement, Governance and Trade

1.0. Introduction

1.1 Background

Ghana has an area of approximately 23.9 million ha and lies north of the equator (between 4°45' and 11°11 North latitude and between 1°14' East and 3 ° 07' West longitude) and wholly within the tropics. Ecologically, the country is made of three broad zones, namely the high-forest in the south (rain and deciduous forest), accounting for about one-third of the land area (8.2 million hectares), a savanna (15.7 million hectares – Coastal, Guinea and Sudan savannah), and a transition zone (1.1 million hectares mostly semi-deciduous forest in the middle belt). The country has 16 administrative regions and the official language is English. Ghana is a tropical country, with tropical species. The forest vegetation consists of evergreen forest with species like *Entandrophragma cylindricum* (sapele), *Khaya ivorensis* (African mahogany), *Ceiba pentandra* (onyina), *Terminalia ivorensis* (emery), *and Melicia excelsa* (Odum).

These zones cover an area of 8.1 million ha, with four broad ecological types**:**

- Wet evergreen
- Moist evergreen
- Moist semi-deciduous
- Dry semi-deciduous forest

These zones have been identified to be floristically similar to the *Cynometra-Lophira-Tarrientia*, *Lophira-Triplochiton*, *Celis-Troplochiton*, and the *Anaris-Chlorophora* associations respectively, recognized by Campbell (2004). According to Campbell (2004), there is no distinct line of demarcation between these associations as one gradually merges into the other. The most productive areas for timber are within the deciduous and evergreen forests. The high forest zones (HFZ) has two major precipitation seasons during April to July and September to November. The precipitation ranges between 1200 mm and 2200 mm, with a short dry season during January and February, and a high relative humidity that is rarely below 85% (Simula 2009). This diminishes the danger of fire in forest estates. The soils in the HFZ are profoundly drained and acidic (pH 4.0 – 5.5) because of high

precipitation. This soil has low cation exchange capacity, available phosphorous, nitrogen and organic matter (Simula 2009). In the wet zones, the soils are very infertile, strongly acidic and often have high aluminum content.

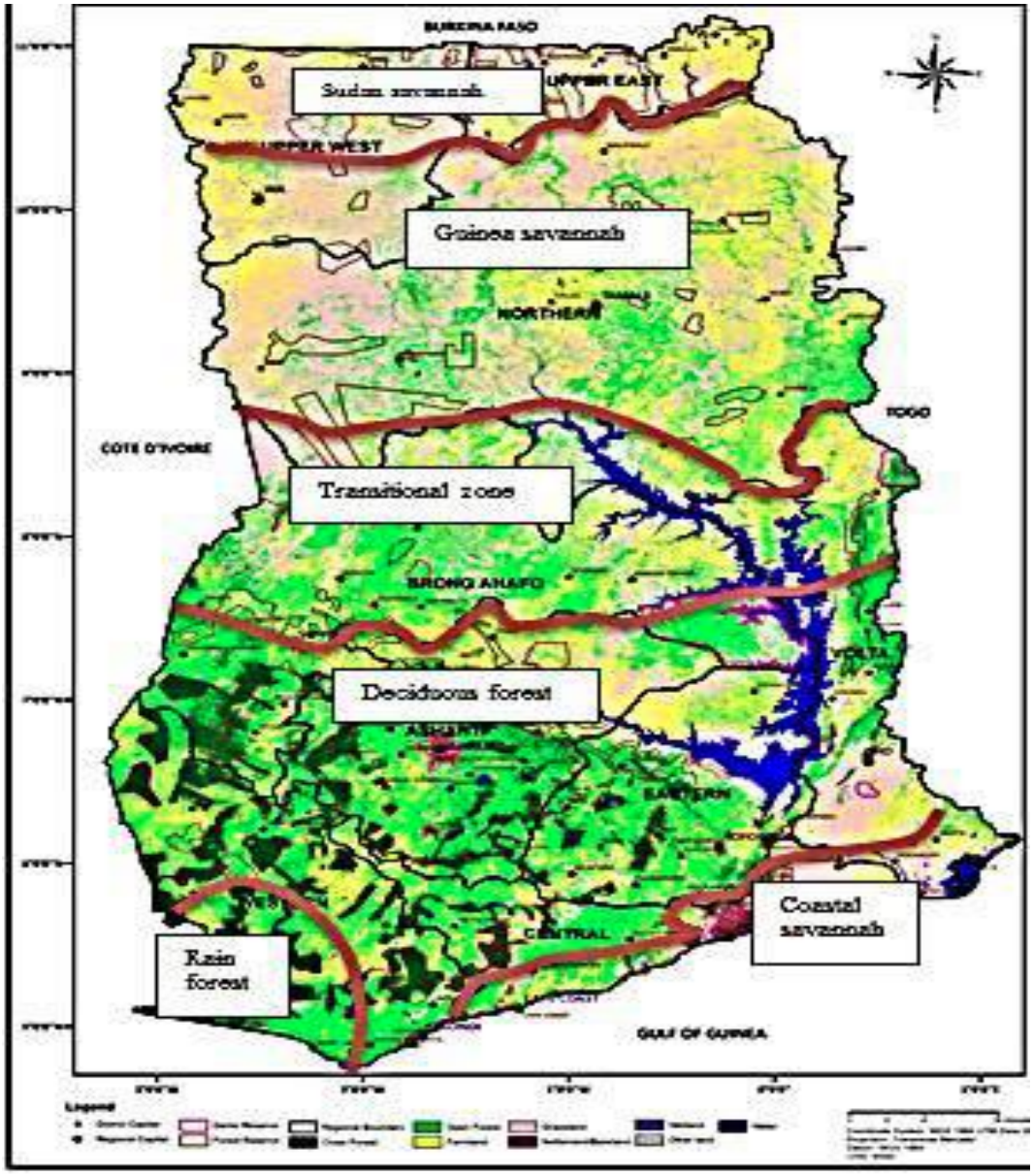

Figure 1. The ecological zones of Ghana

Source: Forestry Development Master Plan (2016-2036)

The Guinea Savannah zone consists of short deciduous, widely spaced, and fire resistant trees. These do not form a close canopy and overtop an abundant ground flora of grasses and shrubs of varying heights (Taylor 1960). The most frequent tree species are *Isoberlina doka, Monites Kerstingii, Burkea aricana, Danielia oliveri* and *Terminalia avecinoides*. Two indigenous species, *Vitellaria paradoxa* (Shea tree) and *Parkia biglobosa* (dwadawa) are conserved by farmers because of their economic value and are therefore common on farmlands. The ground vegetation, which includes *Panicum maxima, Andropogon gayanus and Cassia mimosoides*, desiccates during the dry season and predisposes the savannah to annual fires, which leave the soil surface bare. Two air masses of very contrasting characteristics determine the climate in the zone. The harmattan winds, generally called the North East Trade Winds, usher in the dry season. The South Atlantic Maritime air mass, referred to as the south west monsoon winds which transport moisture into the area during the rainy season. There is a moderate mean annual rainfall of 960 mm to 1200 mm falling in one season from March/April to October showing a very irregular distribution within a rainy season and great differences from year to year (Fisher 2004). Maximum rainfall during the year is achieved in July to August. Mean annual temperature is 28.3°C which does not vary significantly during the seasons.

The soils of savannah zones are varied, because of the varied nature of the underlying geology. In general, however, two broad groups of soils are recognized: the savannah ochrosols and groundwater laterites. The savannah ochrosols are found on the Voltaian sandstones (Boateng 1966). They consist of well-drained, friable, porous loams and are mostly red or reddish brown in color. Most of the areas covered by these soils have a gently topography. Soils in the depressions are thick, but upland soils usually have a zone of iron stones concretions from 100 cm below the surface (Boateng 1966). Despite their deficiency in nutrients, notably phosphorous and nitrogen, these soils are among the best soils in the northern savannah zone and are extensively farmed. A typical soil profile shows a dark greyish humus loam on the surface and subsequent layers from greyish to brownish loam with quartz gravel through light brown clay into moderately compact clays of about 70cm below around level. The groundwater laterites are very extensive and are formed on the Voltaian shales and granites. They consist of a pale-colored, sandy or silty loam with a

depth of 65 cm underlain by an iron path or a mottled clayey layer rich in iron, that hardens to form an iron pan on exposure (Boateng 1966). Drainage on these soils is poor, they tend to get waterlogged during the rains and dry during the dry season. These soils which developed on the Voltaian shales, are among the poorest soils in Ghana and little cultivation takes place on within those soils (Boateng 1966).

2.0 Objectives

Agriculture, including forestry, is one of the strong pillars of Ghanaian economy and provides 43% of the Gross Domestic Product (GDP). The aim of this systematic literature review was to provide an up-to-date empirical knowledge on the socio-economic and other impacts of forest plantations on local communities in Ghana. This review was contributed to the discussions around the impacts, species and their selection, propagation and management of forest plantations in Ghana.

The objectives of the review are to answer the following primary and secondary research questions.

Primary question

•What are the direct and indirect socio-economic and other impacts of forest plantations on local Ghanaian communities?

Secondary question

• What are the challenges forest plantations faces in this context?

3.0 Methodology

A search of scientific literature was made using electronic databases (Scopus and Google Scholar) and of publicly available internet documentation, concerning the socio-economic impacts of forest plantation on the local Ghanaian communities. The review focused on planting, tending, and harvesting practices employed in Ghana to manage forest plantations, the socio-economic impacts of forest plantations and how it affects the local Ghanaian communities. 200 papers occurred in the research, 120 papers were read, and 100 papers were used for the literature review. A review of current knowledge for the research was based on available literature sources, google scholar, as well as the database of FAO, REDD+ program etc.

Furthermore, three cases in details were reviewed: case study 1, 2, and 3.

The selected studied plantations areas were in Dormaa, Begoro, and Offinso Districts. The annual rainfall in these districts ranges from 1,250 mm to 1,500 mm with mean daily temperature ranges from about 25°C (Appiah et al. 2010).

The vegetation at these sites is tropical semi- deciduous forests (TSDF), a vegetation type with an uneven tree canopy between 10 m and 40 m tall. The soils are predominantly infertile (Blay et al. 2008). The main occupation of the local communities in these case study areas is agriculture representing their primary source of food, income, and employment. Many of the rural households either lack access to land or a secure stake in the land they farm. Consequently, high levels of forest degradation persist in these areas. Furthermore, several concerns have being raised for rehabilitation in these forests areas because they have been subjected to heavy timber exploitation.

4.0 Literature review

4.1 General Overview of Ghana's Forests

Ghana is endowed with a vast forest cover and steadily growing to 7% of total global forested areas (Ridder 2007). Forests provide ways to meet local and international demand for timber (Russell & Franzel 2004). The high forest zone is characterized by abundant farmlands and forest reserves consisting of the evergreen and semi-deciduous forests with many subtypes (Hawthorne & Abu Juam 1995). The HFZ is the main source of the country's timber production. The savanna is characterized by an open canopy of trees and shrubs with a ground layer of grass (Hall & Swaine 1981). The savanna zone covers about 9.4 million ha, producing predominantly wood fuel. A transitional vegetation zone exists between the HFZ and the SZ and is characterized by a mixture of savanna vegetation and dry forest.

Forest degradation poses a great threat to the forests in Ghana as deforestation is estimated to occur at a rate of about 65,000 ha per year. The main cause of deforestation is the conversion of forest lands into farms lands to produce food to sustain the growing population. Other important factors include illegal logging activities, mining, constructions of roads and infrastructures, bad farming practices and wildfires. Secondary forest patches and trees around settlements cover a greater part of the off reserves (Mayer's et al. 1996). In the year 2010 the off reserve for timber production was estimated at about 350,000 ha (Ridder 2007). Many commercial timber species were found in these off-reserve areas. Almost half of the timber harvested came from off-reserves in the early and late 90's but this has drastically reduced in recent years (Hansen & Treue 2008). However, efforts are made to regenerate lost forest by various plantation programs initiated by government and private organizations.

The key underlying causes of forests degradation includes population and economic growth and weak governance structures. The increases in population and economic growth have led to high demand for domestic wood consumption and for timber export markets. Moreover, increase demand of domestic and export for agricultural

commodities, such as cocoa, oil palm, cashew, and food crops has led to large scale conversion of forests to agricultural uses.

4.1.1 History of Plantation development in Ghana

At the turn of the 20th century, about one third of Ghana's total land area was covered by tropical natural forest (Wagner et al. 2008). However, there has been a considerable decline of forest cover in the country since 1900, from 8.2 million hectares to about 1.6 million hectares in 1995, a total of about 80.0% loss (Haddon et al. 1995). As indicated by (Kong & Fao 2005), forest resources assessment 2005, an average annual rate of forest loss in Ghana between 1990 and 2000 was recorded at 135,000 hectares per year. Between the years 2000 and 2005, an average rate of forest loss of 115,000 hectares was recorded. This shows that a total of about 26.0% of forest cover was lost between 1990 and 2005. The government of Ghana had to resort to plantation development as a measure to reduce pressure on the natural forests and fill the gap in timber deficit supplied to the local market (Ayine 2008). Plantation development in Ghana has gone through several phases. Nsiah (2009) classifies forest plantation development in Ghana into three phases namely:

- The colonial period (1885-1956) which cocoa and coffee plantations were established using the traditional slash and burn method,
- The post-independence period (1957-1999) which the government begun a massive forests plantation development program in the early 1970s using the Taungya System, and
- A period from 2000 onwards that made the implementation of the National Forest Plantation Development Programme.

4.1.2 Plantation forestry development

Plantations have been the subject of renewed interest in both the public and private sectors in recent years. There have been considerable attempts to define many concepts related to forestry and forest plantations. According to Ford-Robertson (1971) plantation forest is a forest crop or stand raised artificially, either by sowing or planting. Plantations

can also be defined as forest stands established by planting and/or seedling through afforestation or reforestation.

They are either of exotic or indigenous origin, and meet the minimum area required of 0.5 ha, tree crown covers at least 10% of the land area and a total trees height above 5 m. Killmann (2002) defined plantation forest as a planted forest established and intensively managed to produce wood and non-wood forest products for commercial purposes and also to provide environmental services such as erosion control, landslides stabilization and windbreaks.

Reforestation of forests is becoming a major forestry activity in most tropical countries that depend on natural forests for the supply of wood upon realizing the need to embark on plantation projects to support the supplies from dwindling and unsustainable natural forests. Among species that feature predominantly are *Cedrela odorata* (Cedrela), *Terminalia superba* (Ofram), *Khaya ivorensis,* and *Tectona grandis* (teak) because they are fast growing, perform well in Ghana, and are also ranked high in terms of economic importance. The growth of species is not uniform and is affected by both physical and ecological factors (Malettha 2017). If a stand is left untouched from planting, its initial uniformity of similar size with equal growing space progressively disappears.

The nature of plantations is generally simple, they are usually pure stands of the same age, managed to maximize productivity and other benefits that are important to the manager (Maletha 2017). According to Ogbunugafor et al. (2011) the objectives of establishing plantations may fall under timber production for industrial and domestic purposes, environmental protection and rural development. More than hundred tree species may exist for plantation projects, few are widely used. *Acacia, Eucalyptus, Pinus,* and *Tectona* were the widely used species for plantations before the year 2000 (Jun & Weyerhaeuser 2006). *Acacia*, *Eucalyptus,* and *Pinus* account for more than 50% of all tropical tree plantations (Killmann 2002). Native and exotic tree species are widely used for plantation establishment in the tropics and sub-tropics with the exotic one being more common. The dominance of exotic species is attributed to their good growth performance over native species.

4.1.3 The need for forest plantation in Ghana

The reasons for pursuing plantation forestry differ across the various countries in world. In Ghana, the reasons for promoting forest plantations are to ensure that the country can meet the demand for forest products for its growing population, reduce the pressure on the natural forests and contribute to their sustainability. Forest plantations, usually fast-growing exotic species provide forest products to access policy tools to reduce deforestation, protect the natural forest resource, and ensure the availability of forest products to meet social, environmental, and economic aims. Other reasons for pursuing forest plantations include high productivity compared to natural forests, rural and economic development, and for carbon sequestration.

4.1.4 Importance of forest plantation

The natural forests have been able to satisfy forest resources needs in the past. However, the high population growth and the need for foreign exchange development have placed great demands on the natural forests to provide export earnings, as well as to fulfil the country's own needs for timber and non-timber resources (Brobbey 2017). Ghana's population has traditionally relied on natural forests to provide its forest products. However, analyses of demand and supply of the forest resources suggest that in future, demand would outgrow supply and hence new resources needed to be created (Nanang 2012). Currently, demand for treated poles for rural electrification projects exceeds the supply from the existing plantations. Cobbinah et al. (2004) also found out that in Ghana, the maximum volume of timber that sawmills can handle is greater than sustainability harvested. It is now considered that tree plantations cannot be avoided if the forest resources being used up are to be resupplied and reduce the urgent demands on the remaining natural forest. Forest plantations play many roles, such as supply local industries with timber, provide timber for export, protect the soil and watershed, and provide a suitable home for wildlife when combined with natural forests (Cobbinah et al. 2004).

4.1.5 Deforestation

Hawthorn and Abu Juam (1995) defined deforestation as deliberate removal of forest by human activities. People need forested land to raise crops and to graze livestock, wood for construction purposes and domestic energy supply, trees and herbs for medical purposes, game, as well as other minor socio-economic activities. Man's demand for the forest and its resources increases consequent to the ever-growing human population. As exploitation exceeds sustainable levels, the natural composition, structure and functions suffer damage to such an extent that the forest ecosystems balance topples, resulting in a changed population levels and diversity of organisms in an unnatural manner. Structures required for ecological processes and populations in latter temporal phrases are also removed. This eventually paves a way for degradation and subsequent deforestation.

4.1.6 Causes of deforestation

The loss of natural forest can be attributed to several factors. These factors were identified by Boyle & Boontawee (1995)

- Agricultural expansion
- Urbanization and industrial expansion
- Infrastructural development
- Shifting cultivation
- Exploitation for fuelwood, charcoal and poles
- Commercial logging for veneer, sawn timber
- Surface mining

Asibey (1991) stated other causes of deforestation as population growth, lack of land use planning, poverty, inadequate of institutional capacity and government policies. Asibey (1991) stated that to investigate the effects these factors, it was found that large scale of agriculture (86.4%) was the most important cause of deforestation while shifting cultivation (59%) takes the second place. Fuelwood (51%) was the third rank, annual bush fire (41%) and timber extraction (27%) was considered as important cause of deforestation in the southern part of Ghana.

People destroy or degrade forest because for them the benefits seem to outweigh the cost (Hellmann et al. 2016). Deforestation can be natural or anthropogenic activities. The deforestation process by anthropogenic causes can be observed in two forms: namely the direct or immediate cause and the indirect or underlying causes.

The underlying factors are those, which help create the conditions in which forest are destroyed. The conditions may be social (example, population pressure, unemployment), political (local government policies and land ownership issues), economical (world trade system, local industries) etc. Tropical deforestation thus results from a number of interconnected causes, all of which are related in some way to population growth, poverty or certain government policies (Islam 2004). In Ghana, inappropriate forest tenure, market failures, government failures, population pressures, are the major indirect factors for the deforestation process. Population pressure is significant if not the predominant factors in deforestation (Tucker & Townshend 2000).

Numerous studies have suggested a relationship between forest trends and population trends at the global scale. In countries with rapidly expanding population the forest land area is also rapidly contracting. Conversely, where the population is stagnating or growing slowly, forest land is expanding (Mather 2000).

Poverty: International debt in underdeveloped and developing countries mostly located in the tropics, government and industries in the promotion of international debt has forced several of factors of such countries to liquidate their natural resources as assets to service their national debt repayments (Dudley et al. 1995). International agencies also encourage developing countries to borrow huge sums of money from developed countries to finance projects such as roads, mines, oil drilling, logging operations or dams in the tropical forests. To stimulate economic development (and in some cases to pay the interest on loans from developed countries), these countries often sell off some of their timber and other natural resources mostly to developed countries (Islam 2004).

Illegal commercial logging: illegal commercial logging degrades tropical forest and its exploitation of timber on behalf of domestic and foreign use account for six percent of tropical deforestation. As export of logs and sawn wood is a source of foreign exchange

receipt, so it is stimulated by those domestic government. The net transfer of wood volume from developing countries to developed countries is about 70 million m^3 per year, rendering such observation relevant to the frequently heard argument that demand from the developed countries from developing countries timber supplies is a major cause of tropical deforestation (Baidoo et al. 2000). Japan alone, for example, accounts for fifty-three per cent of the world's tropical timber exports and import followed by Europe (forty two percent) and United States (fifteen percent). Currently, almost three fourths of exported tropical timber comes from South-East Asia (Miller 1998). In Ghana, logging does not only change the composition but also result the depletion of forests.

Fuelwood cutting: Another significant cause of degradation and deforestation around cities is the use of firewood and charcoal (Dudley et al. 1995). Global fuelwood consumption figures are much less reliable at about 1.8 billion m^3 annually at present (Baidoo et al. 2000.). In Ghana, people are forced to walk up to ten kilometers to collect fuelwood which is the major source of energy for most households (Aina & Odebiyi 1998). In 1992, about 15.2 million m^3 of fuelwood (firewood and charcoal) was produced, which is about ninety percent of the wood removed from the forests of Ghana (Iftekhar & Islam 2004).

4.2 Stakeholders involved in plantation development in Ghana

According to Dumenu (2010) stakeholders are persons and institutions who have an interest in a resource and have right to use or benefit from the resource. These also include persons who take decision to govern the use of the resources and whose actions or negligence can impact on the resource positively or negatively. There are two main types of stakeholders mentioned by Kotey (1998). Firstly, those who are directly affected by the resource referred to as primary stakeholder and those who are indirectly affected by the resource, known as secondary stakeholders. In the off- reserve areas, primary stakeholders involved in plantation development includes farmers, buyers (middlemen, timber companies) and traditional authorities (Dumenu 2010). The Forestry Commission is the statutory body responsible for the management of the forests resources.

The forestry commission is responsible for all operational activities relating to forest management, protection and development. Further, it is the agency in charge of control and implementation of forest and wildlife resources, the conservation and management of those resources and co-ordination of policies related to them. The Forest Service's Division (FSD) in collaborates with Resources Management Support Center (RMSC) ensure planning, management, monitoring and also control the timber utilization in reserves and off-reserves areas in Ghana. Traditional councils customarily comprise several stool chiefs and divisional chiefs with the paramount chief as the head. These are traditional governing bodies in the customary setting and wield certain powers in terms of decision making in their various jurisdictions. The traditional councils and stool lands are the authorities of the high forest zones according to the statutory and customary laws of Ghana. They own all lands in the off-reserve areas that are used for tree planting.

Farmers are key stakeholders in off-reserve plantation development. Many farmers practice agroforestry on their farms to improve their crop yield. Most of these farmers use indigenous knowledge for the management of their trees and hence have very little or no interaction at all with the relevant technical institutions for support (Dumenu 2010). The buyers of timber in the off-reserve areas include middlemen, wood processing companies, timber companies and foreign merchants (Nsiah 2009). Often, middlemen buy trees from farmers and in turn sell it to foreign timber merchants or wood processing companies for processing.

4.3 The extent of forest plantation in Ghana

Forest plantation development in Ghana is currently led by Forest Services Division (FSD) and Forestry commission (FC) which are responsible for the implementation, coordination and management. The programme is currently being implemented under three main strategies:

- The Modified Taungya System (MTS)
- Government Forest plantation Development Programme (HIPC) and

- Private Plantation Development. A purely research-based model plantation component was added in 2007 to offer the plantation executives the opportunity to manage species trials, experiment various planting designs and tree spacing trials (Ayisi & Akabzaa 2010).

4.3.1 Modified Taungya System

The Modified Taungya System (MTS), developed in Myanmar (formerly called Burma), is a plantation model, in which farmers are given degraded forest reserves to produce food crops and to help established and maintain timber tree (Agyeman et al. 2003). The farmers have a 40% share in the returns from the investment. The Government in collaboration with Africa Development Bank (AFDB) and Community forest management projects (CFMP) has 60% shares. The second strategy utilize hired and paid workers a monthly allowance to establish and maintain plantation, while plantation supervisors are given one year renewal contract to supervise and offer technical direction (Birikorang et al. 2007). This strategy is under the Government Plantation Development Programme (GPDP). The 1994 Forest Policy encourages the establishment of forest plantations and calls for provision of incentives for their establishment and management. The main legislation governing forestry plantation development in Ghana is the Forest Implantation Development Fund Act (Act 583) to offer financial support and other incentives to plantation developers in the private sector. The Act was subsequently amended in 2002 into the Forest Development Fund Amendment (Act 623) to cover plantation growers, both in the public and private sectors.

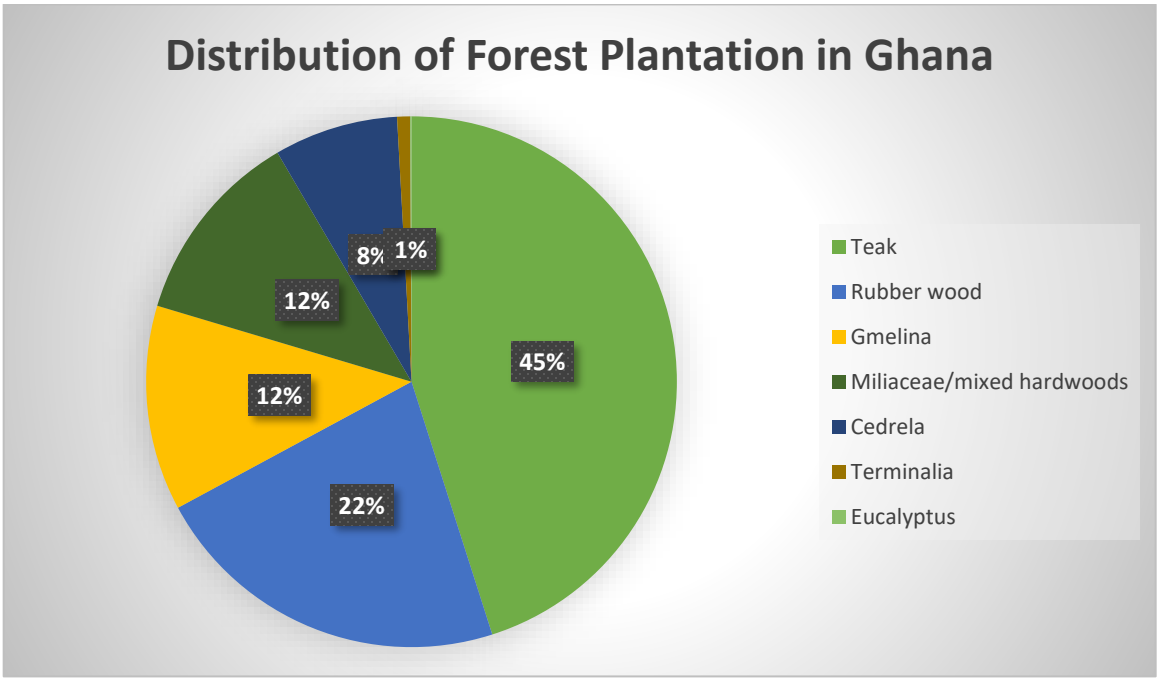

Figure 2. Distribution of forest plantation in Ghana

Source: www.fcghana.org

4.3.2 Area of forest plantation established between 2002 and 2008.

Ghana had established approximately 140,000 ha of commercial timber plantations between 2002 and 2008. The most attractive species for plantations establishment in Ghana was Teak which constituted over 70% of the commercial plantations established (Schweppe et al. 2013). It was expected that 20,000 ha of plantations would be established each year for 25 years and that the management of the plantations would be efficient to achieve a yield of about 390 m^3/ha. There were a lot of barriers facing forest plantation development in Ghana that resulted in few plantations being established and that are not well managed. The barriers limiting the development of forest plantations include ambiguous land and tree tenure arrangements, lack of technical expertise, poor extension services, and uncertainty about markets for timber. Other factors were the inability to control wildfires, poor financial incentives. Since the year 2003 there is continuing deteriorating nature of the rate of commercial plantation establishment and the quality of the established plantations are worrying developers since the natural production systems for timber continue to experience

degradation and depletion. Only approximately 12% of the total area of commercial plantations established within this period has received tending operations. This raised concerns about the future yields from the plantations and Ghana's ability to bridge the gap between demand and supply of timber, for which the plantations were established.

Moreover, the continued destruction of the forests will result in the emission of millions of tons of carbon at a time when there was concerted global effort to reduce carbon emissions. The production systems in their current degraded state cannot sustainably meet the industry demand for timber. It suggests also that the current annual allowable cut is no longer a valid standard or guideline of a sustainable harvest level from the forests since the main production systems cannot supply the current AAC of 2 million m^3 on a sustainable basis. There is no doubt about the potential of commercial timber plantations to satisfy the demand for timber in Ghana.

However, current commercial plantation activities in the production systems indicate that present plantation establishment efforts are not sufficiently successful to bridge the gap between demand and supply of timber, as a result of low rate of establishment and lack of management of the established plantations. The combined effect of land and tree tenure issues including farmers rights to trees they manage on agricultural lands, acceptable benefit sharing arrangements and lack of attractive financial incentives weaken potential investors' confidence that forest plantation establishment in Ghana can be a profitable undertaking. The policy implication is that secure tenure and rights to trees in the cropping system is a key condition to stimulate large scale planting of forest trees by farmers and other investors. Farmers must feel confident that their rights to trees on agricultural lands will not be taken away in the medium to long term. Considerable efforts are urgently needed to increase the rate of current commercial plantation establishment in both degraded forest reserves and off-reserve areas. There is also the need to promote sustainable harvests in the production systems by aligning the AAC and actual harvest to the capacity of the production areas. At the same time, there was a need to pursue alternative sources, such as importation, to bridge the gap between the demand and supply of timber in Ghana.

The implementation of the programme, however, began in 2002. The planting target of 20,000 ha per annum was reduced to 16,520 ha in 2004 and further to 10,000 ha in 2005. The annual targets were reduced to allow the forest services division field staff to cope with the large annual target while, at the same time maintaining the large areas already established (Birikorang et al. 2007) .

A wide range of tree species were planted in the plantations, including both indigenous and exotic economic tree species. The indigenous species include *Mansonia altissima* (Oprono), *Terminalia superba* (Ofram), *T. ivornesis* (Emire), African Mahogany *Ceiba pentandra* (Onyina), *Heritiera utilis* (Nyankom), *Entandorophragma angolense* (Edinam), and *Triplochiton scleroxylon* (Wawa) and the exotics are predominantly *Tectona grandis* (Teak), *Cedrela odorata* (Cedrela) and *Eucaluptus camaldulensis* (Eucalyptus). The exotic species form about 95% of the areas planted (Darku 2016).

Table 1. Area planted under the National Forest plantation Development programme from 2002-2008

Year(yr.)	**Area planned (ha)**					
	Modified Taungya System (MTS)	**Community Forest Management Project**	**HIPC funded**	**Private Developers**	**Model Plantations**	**Total area**
2002	17460	-	-	1609	-	19069
2003	17691	-	5650	1609	-	24950
2004	16090	-	5300	1609	-	22999
2005	9105	1136	6575	1609	-	18425
2006	9401	2298	6075	1609	-	19383
2007	8711	2731	5312	1613	69	18436
2008	111	2930	3740	5374	160	12314
Total	78569	9095	32652	15032	229	135576

Source: Ghana Forestry Commission (2008b)

4. 4 Species selection for plantation development in Ghana

The choice of species to be used is one of the most important factors to consider in plantation establishment. The choice depends on the purpose of the plantation, the available species for planting, which species will match the available site (Evans and Turnbull 2004). In addition to choosing tree species to match their most productive sites, species are also chosen to fulfil the purpose of establishing the plantation. There is also the question of whether the plantation should be a single species (monoculture) or multiple species (mixed). Each of these has their advantages and disadvantages. If the forest plantation is to provide only wood products, then most often, a single species suitable to the site may be enough. However, if the purpose of the plantation is to provide services such as aesthetic values, protection of wildlife habitats, biodiversity conservation and timber, multiple species plantations will be favored. According to Cobbinah et al. (2004), there is no restriction as to what to plant, as any tree species suited to the site and with commercial value may be planted.

However, since tree plantations lock up investment over relatively longer period, it is important to seek technical advice on the following: site requirement for species, quality of planting materials. Tree species that are water intensive should neither be planted in the drier areas nor used as ecological restoration around rivers or streams. Species for restoring degraded lands and watershed protection should have characteristics that are consistent with their functions such as fast growth, provision of shade, litter production, deep-roots, erosion resistance, etc. When it comes to ecological restoration, the use of exotic species has the potential to cause problems since they are often more aggressive than the indigenous species and can alter ecosystem structure (Brobbey 2017).

4.4.1 Site selection for plantation development in Ghana

A second important consideration is selecting the site for the plantation. Good site selection a vital decision that help to improve yields, reduce rotation lengths, and increased economic returns for plantations (Mateiyenu Nanang 2012). In this case, the most important factor is to match species with the site in order to optimize productivity, as every land has specific properties that affect the growth of what is planted. Furthermore, sites are

selected to minimize the risk of plantation failure due to poor soil drainage, drought or inability to control weed competition. Cobbinah et al. (2004) indicated that trying to grow trees that are not well adapted to the land and climate may delay or slow down their growth and increase the risk of pest attacks and diseases. Soil drainage and depth, soil physical and chemical composition, soil moisture availability, winds, storms, fires other climatic factors of the area are very important components to be considered (FAO 2001).

The following can be helpful in selecting the best species for a particular site: the soil type (soil texture- sandy, loamy, clayey), presence of restrictive layers (iron pans/hard pans) and depth of bedrock, soil properties (acidic, neutral, and alkaline), water retention capacity and rate of drainage, the rainfall pattern (total annual rainfall and duration of the drought period). A general way in evaluating site quality is to analyze the significance of contending vegetation, and populations of animals, for example, insects and microorganisms that are either harming or useful to the trees, which can influence the management of forest plantation sites (FAO 2001).

Site selection may be limited by the availability of land for the investors. Most small-holder farmers would be restricted to planting trees on their own farmlands or family lands, which may not be the most suitable for forest plantations. This would reduce the productivity of such plantations, thereby requiring more land to achieve the same level of output. Community plantations rely on communal lands, while industrial plantation investors would acquire large tracks of land through purchasing or leasing. Industrial investors have the most flexibility in choosing the site, since they would be purchasing or leasing the land. Large scale investors would also need to consider the location of the plantations via processing facilities, markets for their products, cost of land preparation, labor force availability and available infrastructure.

4. 5 Selected Plantation Species in Ghana

4.5.1 Teak (*Tectona grandis*)

Tectona grandis is one of three species in the genus *Tectona* belonging to the family *Lamiaceae*. It is the most popular commercially known timber species in the tropics and subtropics parts of the world due to its valuable high yielding timber. It is a native species to India, Thailand, Myanmar, and Laos (Kaosa-Ard & Apavatjrut 1989) and has also been successfully naturalized in many South America and in many African countries including Ghana.

Figure 3: Plantation of Tectona grandis

Source: http://tropical.theferns.info

4.5.11 Ecological Demands of *Tectona grandis*

Teak is a strong light demanding species requiring between 75 to 100% of the full sunlight for successful growth. It is also sensitive to frost and drought. In its natural ranges,

it tolerates temperature as low as 2 °C to as high as 48 °C and the total annual rainfall from 750 mm to 5000 mm (Vaishnav & Ansari 2018). It coppices and pollards vigorously and escapes damages from frost and drought. The variability in teak is largely due to the occurrence of cross-pollination which helps the species to survive in the different sites (Palanisamy et al. 2016).

4.5.12 Industrial Uses of *Tectona grandis*

Teak excellent properties make it useful for a wide range of purposes, such as exterior and interior joinery, window and door frames, flooring, cabinet work, garden furniture, decking, boat building, bridges and railway (Borota 1991). In Ghana, Teak is cut into poles for carrying electric cables, telephone lines and streetlights. Many parts of the teak tree have potent medicinal properties because of the presence of different alkaloids, flavonoids and phenolic compounds. Preparations from the leaves are used in traditional medicine.

4.5.13 Site Requirements

Teak grows on a variety of geological formations and soils (Kadambi 1972) but the quality of growth depends on the depth, structure, porosity, drainage, and moisture holding capacity of the soil (Kadambi 1972). Teak grows best on deep, well drained and fertile soils with a neutral or acidic pH (Kadambi 1972). Warm tropical, moderately moist climate is best for teak growth. Optimum annual rainfall for teak is 1200 to 1600 mm, but it endures rainfall as low as 500 mm as high as 5000 mm (Kadambi 1972).

4.5.14 Propagation

Teak plantations represent 4% of the total area of planted forests due to its global demand, teak has good prospects as a plantation species (Krishnapillay 2000). Planation grown teak is established using stump plants rather than direct sowing of teak seeds which does not give satisfactory results (Borota 1991). Depending on desired product (fuelwood, poles, lumber or a mixture of products) and the site quality, the initial planting spacing generally range from 1.8 m by 1.8 m to about 3m by 3 m (Kadambi 1972). When planted in

a taungya system, spacing could be as wide as 4.5 m between rows. Generally, on good soils, wider spacing is used. This results in better diameter and height growth, and reduces nursery, planting and early thinning costs (Kadambi 1972).

4.5.15 Management

Teak is generally shade intolerant but needs training for improved form. Accordingly, teak plantations must be thinned regularly, particularly in the first half of the rotation. Initial planning density is generally between 1200 and 1600 plants per hectare (Krishnapillay 2000). Closer planting spacing is sometimes adapted to ensure quick canopy closure. However, this practice necessitates early thinning. The time of the first thinning is largely determined by size quality. Although thinning may be delayed for 10 to 15 years after planting without unduly affecting the growth potential of the final crop, very heavy thinning becomes necessary if the growth of the final tree crop is to be maintained at satisfactory levels. Teak also coppices quite vigorously, making post-harvest re-establishment much easier than from seed.

4.5.16 Leaves of *Tectona grandis*

The leaf is simple, opposite, broadly elliptical or obovate, acute or acuminate, coriaceous, possessing minute glandular dots as shown in figure 4 below. The leaves have a leathery feel, glabrescent above, hairy and scabrous below and are pinnately veined (Palanisamy et al. 2005).

Figure 4. Leaves of Tectona grandis

Source: http://tropical.theferns.info

4.5.2 *Cedrela odorata*

4.5.21 General Description

Cedrela odorata belongs to the family *Meliaceae*. It is a deciduous tropical tree that grows to a maximum height of about 30 m to 40 m and it is widespread in seasonally dry tropical and subtropical forests. About two-thirds of the bole is clear without branches and the wood has a strong aromatic odor with a woody capsule fruit which contains very small winged seeds which spread when the when the ripened fruit splits open. In large trees the bole often bears plank buttresses that can extend up to a 3 m in height, it is usually straight, cylindrical and often free of branches up to about 20 meters above the ground, the crown is very broad and sparse and therefore does control weeds (Lamprecht 1989). *Cedrela* can be pollinated by insects and has wind dispersed seeds (Carvers et al. 2004).

The species flowers annually, but good seeds occur every 1-2 years. *Cedrela* is listed in the category of species that face a high risk of extinction in the wild in the medium term, due to over exploitation.

4.5.22 Ecology and Silviculture

In Ghana, it had planted in plantations in the high forest zones in the Western, Eastern and Central Regions, and also as avenue trees in towns (Brobbey 2017). *Cedrela odorata* stocks best on the driest, best-drained sites in the evergreen and semi-deciduous rain forests. It is nutrients demanding and does not do well in waterlogged areas. The specie tolerates soils rich in calcium, and prefers fertile, free drained and weak acid soils (Orewa et al. 2009). In Ghana, *Cedrela* has been successful in the few plantations established in the moist evergreen and semi-deciduous zones (Downes et al. 1997). The root system of *Cedrela* is superficial and this makes the tree subject to wind damage especially after thinning. Transplanting of naturally regenerated seedlings and stem cuttings are the most common propagation methods. In the natural forest, it is therefore a species that regenerates well in forest clearings, on abandoned agricultural sites, and on favorable sites even under a light canopy. Natural regeneration can be encouraged by removing the canopy around seed trees and gradually lightening the over wood (Lamprecht 1989). The mahogany shoot borer *Hypsipyla grandella* is a serious insect pest which attack *Cedrela*. The larvae of this moth eat the pith just behind the growing tip of fast-growing shoots, causing death of the apical meristems, which slows seedlings and sapling growth and may ruin tree form.

4.5.23 Uses of *Cedrela odorata.*

Cedrela odorata is widely harvested for use as timber by virtue of its durability, excellent viability and appearance. It is a redwood of fine texture and uniform grain with high luster and a distinct odor (Downes et al. 1997). It is moderately resistant to decay and works easily with all tools and finishes well. It is used for veneer and plywood production, indoor and outdoor construction, furniture, lathe turning, musical instruments and domestic utensils, it is the best wood for building canoes and sporting boats. *Cedrela* tree has many

lower branches and spreading crown, which make them suitable for use to provide shade and windbreak in courtyard garden and in parks (Orwa et al. 2009)

Figure 5. An eight-year old pure Cedrela odorata stand in Tano Offinso Forest Reserve

Source: http://tropical.theferns.info

4.5.3 *Terminalia superba* (Ofram)

4.5.31 General Description

Terminalia superba locally known as ofram belongs to the family *Combretaceae.* It is a commercial species of abundant occurrence, very high production and regular export. The tree is large and grows up to 50 m high, a girth of 3 m, with a straight bole and a spreading crown. The buttresses are up to 2.5 m tall, bark silvery-grey; loose and scaly with

yellow slash, branching system is horizontal and almost in regular whorls, leaves simple up to 18cm long and 10cm broad, obovate, glabrous, acuminate at the tip with long petioles, flowers (January to June) yellowish-white, loose pendulous axillary spikes 10 cm long, samara fruits about 3 cm by 6 cm, mature in November, each being one-seeded with two lateral wings. It has fine texture to moderately coarse with low luster and wood is hard, medium dense (Dadzie et al. 2016). Older trees have tall, well defined buttresses often running 4-5 m up the bole. The bark and buttresses of *Terminalia superba* make it easily distinguishable from *Terminalia ivorensis*.

Terminalia superba is a deciduous tree and is widely spread throughout the high forest zone but is more common in the drier areas and secondary forest than in the wetter areas where it is generally rare. It grows well in areas with high amount of rainfall. Ofram tolerates a wide variety of soils for example alluvial soils, and also found on other soils. Thus, the species will grow on light, medium and heavy textured soils and on a wide soil pH ranging from acidic neutral through to alkaline soils. The young plant tolerates slight shade at first but requires full overhead light for good development. Growth is fast after the 1st year and is widely used as a plantation species in Ghana and West Africa where height increment of 1.5 m to 3 m has been recorded after 4 years and a girth of 10cm at breast height after 13 years (Taylor 1960). On a good site Ofram is expected to reach a diameter (at breast height) of 60 cm to70 cm in 40 years.

4.5.32 Uses of *Terminalia Superba*

Terminalia superba is nondurable wood used for furniture, cabinet works, interior joinery, frames and trims paneling claddings and molding. It is also used for rotary, decorative veneer and plywood (Dadzie et al. 2016). The wood of Ofram has excellent technical properties and has many ends uses including core and face veneer for plywood production, internal and external joinery and furniture making. According to Brobbey (2017) Ofram has some potential for pulp and paper production, hence its thinning could be utilized in the pulp and paper, as well as the particleboard industries.

Figure 6. An eight-year old Mixed stands of Cedrela odorata and Terminalia superba stand in Tano-Offinso Forest Reserve

Source: http://tropical.theferns.info

4.5.4 *Triplochiton Scleroxylon* (Wawa)

Triplochiton Scleroxylon (known in Ghana as Wawa) is a major commercial timber tree of West and Central Africa. In Ghana, it is found in the natural forests of the moist evergreen, moist semi-deciduous and the forest-savannah transition zones. The potential of Wawa to be used in plantation development has been recognized, although there are no large-scale plantations in Ghana. Wawa has been heavily exploited in Ghana for many decades. Available records show that in 1959, Ghana exported 650,000 m^3 of logs and 30 000 m^3 of sawn timber (Bosu et al. 2006). As a result, a ban on the exports of Wawa in log

form was implemented in 1993, which subsequently shifted the exports to secondary and tertiary wood products. In 2009, about 36733 m^3 of Wawa exported in the form of Kiln-dried lumber, earning about 10 million euros (Adu-Sarpong 2017).

Figure 7. A picture of Triplochiton Scleroxylon (Wawa)

Source: http://tropical.theferns.info

4.5.41 General Description

Triplochiton scleroxylon (Wawa) belongs to the family *Sterculiaceae*. It is a large deciduous forest tree commonly attaining 45 m height and 1.5 m diameter. The boles of

mature trees are often heavily buttressed but usually free from branches (Orwa et al. 2009). The timber is whitish to pale with no difference from heartwood and sapwood, while the texture is medium to coarse with grain typically interlocked that gives a stripped figure. The wood has an unpleasant smell when green but usually does not persist after drying. The heartwood is whitish to pale yellow, indistinctly demarcated from the sapwood, which is up to 15 cm thick. Leaves are 10 cm to 20 cm long and broad, palmate with 5-7 lobes, cordate and 5-7 nerved at base, lobes broadly ovate, triangular or oblong, rounded or obtusely acuminate at the apex, glabrous, stalk 3cm to10 cm long (Orwa et al. 2009).

4.5.42 Distribution

Wawa is widely distributed in West and Central African forest zones from Guinea east to the Central African Republic, and south to Gabon and the Democratic Republic of Congo. *Triplochiton scleroxylon* is mostly planted in its natural area of distribution in most West African countries such Ghana and Nigeria, and occasionally in the Solomon Islands (Bosu el at. 2006).

Within its natural limits, Wawa is found mainly in forests at low and medium altitudes in the monsoon equatorial forest belt. Throughout its natural range, there is always a market dry period between December and April. Wawa is referred to as a pioneer species, and it has been suggested that shifting cultivation in West Africa has influenced the natural distribution (Orwa et al. 2009). The extensive forest disturbance results from human activity, Wawa may invade areas, where it was formerly rare or absent, becoming closely associated with a group of species quite different from that with which it grew originally.

4.5.43 Site Requirements

Wawa occurs up to 900 m altitude in regions with an annual rainfall up to 3000 mm but is most abundant at 200 m to 400 m altitude an in areas with an annual rainfall of 1100 mm to1800 mm and two rainy seasons (Bosu et al. 2006). It prefers more fertile, well drained, ferruginous soils with light or medium texture and acid to neutral pH (Bosu et al. 2006). It does not tolerate water logging, and in general avoid swamps.

4.5.44 Management

In tests, wood material from plantation-grown trees was found not to be inferior to trees harvested in natural forests (Bosu et al. 2006). The high growth rates allowing comparatively short cutting cycles, the generally good form of the boles, and the possibility of planting in mixtures with other timber species make Wawa even more promising. *Triplochiton scleroxylon* has been used for plantation establishment in Ghana and Nigeria (Arias 2003). From 1967 to 1995 about 3000 ha was planted in Ghana, where they are grown on a cutting cycle of less than 40 years. In Nigeria, Wawa is planted in agroforestry systems with cocoa (Bosu et al. 2006)

4.6 Harvesting and management of trees and forest plantation

The policies lay down the procedures for harvesting and disposing forest resources is under Forestry Commission to ensure proper management practices. The procedures and conditions prescribed for proper harvesting and the additional requirements expected of timber right holders can sum up the conditions that ensure sustainable forest management, and poverty reduction in forest fringe communities. The requirements of timber right holders before harvesting include:

- Social Responsibility Agreement (SRA)
- Reforestation plan
- Social amenities
- Specifications of timber operations.

A social responsibility agreement must be settled between the holder of a Timber Utilization Contract and the community that owns the land or forest. According to the logging manual, the Social Responsibility Agreement should contain a code of conduct requiring the Timber Utilization Contract holder to respect the rights of the landowning communities in order not destroy their farming operations, and Non-timber forest products.. Other rights and obligations can be added as appropriate. The regulation stipulates that the reforestation or afforestation plan must provide at least 10 hectares of forestation for each square kilometer of contract area (i.e.10 percent of the area allocated). It does not mention where such forestation should take place. The Timber Utilization Contract holder must

provide social amenities to the inhabitants of the contract area, the cost of which should not exceed 5% of the annual royalty accruing from operations under the timber utilization contract.

The Timber utilization Contract holder also must agree with the landowning communities the timber operational specifications, include obliging the timber utilization contract holder to provide a certain number of offcuts for community use, employment, financial support (Amoah et al. 2009). The technical conditions for proper harvesting prescribe that no harvesting is permitted without a timber utilization contract. This means that even the person who planted and maintained the trees cannot harvest them for commercial purposes without a timber utilization contract. Timber utilization contracts outside forest reserves cannot be granted without the written permission of the landowner on whose land the forest plantation or timber stands. If the landowner does not give permission, a committee should consider whether he/she is justified and should then submit a report to the regional forestry manager with the comments and recommendations of the district manager. If neither the landowner's permission nor a committee report can be obtained, the Timber utilization Contract cannot be granted.

The amendment act has removed this class of forest tenure from Timber utilization Contract allocation procedures. While the Timber utilization Contract applies to all the trees in a stipulated area, a Timber utilization Contract allows the harvesting of only a specified number of trees. A Timber Utilization Contract can be granted to a community, town committee, rural community group or Non-Government Organization to harvest several trees for social and community purposes from areas that are not under Timber Utilization Contracts (Amoah et al. 2009).

4.6.1 Harvesting Practices

A silviculture system and management activities related to forests plantation from planning, tending to harvesting in Ghana, forests plantation are managed under one or a blend of three silvicultural systems:

- The clear-cut system removes most of the trees from an area, with patches of trees and buffers left to protect other values.

- The shelter wood system harvests trees in stages over a short period of time so the new forest grows under the shelter of the existing trees.
- The selection system involved cutting of single trees or in small groups at relatively short intervals, repeated indefinitely. This is done carefully to protect the quality and value of the forest area.

Forest managers consider socio-economic and ecological factors about the silvicultural systems. Silvicultural systems are very important each forest site. The clear-cut and shelter wood systems are used to manage even-aged forests, which are defined by relatively small age differences between individual trees. Clear cutting of trees is generally the most ecologically appropriate way to harvest and renew the boreal forest because it most closely resembles the large natural disturbances, such as fire, wind, floods and insects, which are common in the region. Boreal tree species germinate and grow best in full sunlight, resulting in natural, pure stands of trees of the same age. The selection system is used to manage uneven-aged stands, which means the forest has trees in various stages of development, it is appropriate for species that thrive in shade such as western red cedar and sugar maple. It is also commented that traditional practices were generally "based upon immediate profits and the exploitation of the forest with little or no thought to the future." The disadvantages of selective logging as: there was no marked advantage in cutting only the largest trees for some products (cross ties, poles, etc.); more care was needed to remove the timber; the immature timber had to be protected and taxes paid on it; it was not useful in even-aged forests or dense forests; and it could not be practiced in areas cut under enforced liquidation of standing timber assets. Heavy taxation encouraged liquidation of standing timber asset.

4.6.2 Positive environmental impacts

The positive environmental factors to planted forests plantation agroforestry include significant reducing carbon emissions through carbon sequestration (van Wilgen & Richardson 2012). About 2,900 million metric tons of carbon reduced annually due to the conversion of farms land to tree planting. Also, there is improvement of hydraulic properties of soil and thus reduction in surface runoff through afforestation (Richardson

2012). The annual runoff was reduced on average by 44% and 31% when grasslands and shrub lands respectively. Eucalyptus afforestation reduced the runoff by 75% compared to a 40% decrease where grasslands were afforested. Plantations forests can reduce the pressure on natural forests for firewood and enhance biodiversity in landscapes that might otherwise contain only monocultures of agricultural. Agroforestry can control runoff and soil erosion, thereby reducing water loss, dryland salinity and mitigates flooding, while Cole (2010) asserts it utilizes marginal areas with low opportunity costs. According to Kalame (2009), reforestation of the degraded land offers indirect benefits that could include: improvement of soil fertility, control of water and soil erosion, regulation of water quality, and prevention of desertification. Planted forests are neither inherently good nor bad, rather it is the choices we make about how to use them that determine whether they contribute to, or detract from, broader societal goals such as poverty reduction and nature conservation (Vogiatzakis et al. 2006). Forests plantation is therefore very important as it provides environmental benefits such as water quality improvement, carbon sequestration, and habitat for wildlife.

4.6.3 Negative environmental impacts

The negative impact includes planted forests leading to loss of ecosystem services and biodiversity (Richardson 2012), and plantation species may become invasive species (Van Wilgen and Richardson 2012). According to Van Wilgen and Richardson (2012), the increased biomass associated with forests plantation can lead to higher intensity fires and other detrimental effects, including encroaching on fragile ecosystems. Chemical use may cause run off into surface and ground water, creating adverse ecological impacts (Lyons et al. 2014). The concept of responsible forest working group includes investors, banks and organizations such as FAO. There are costs such as replanting, silvicultural activities, maintenance and thinning involved when evaluating the impacts of plantations and associated forestry operations in Ghana and Africa as a whole. The biological stock remains stable in the long run.

Plantations and agroforestry supply timber and decreases negative environmental impacts compared to natural forests (Kaboggoza 2011). The range of timber and non-timber products, including carbon, can diversify revenues (Purdon & Lokina 2014) and benefit both large and smallholders. Plantations create more stable business environments and local infrastructure such as schools, roads and bridges in the East African region. Forests plantation associated with industrial activities have create high shareholders returns, stability for suppliers and buyers, and revenue from taxes for governments (Ingram et al. 2016) contributing to poverty alleviation (Kaboggoza 2011). Fisher (2004) indicates that income from forests reduces income inequality by 12% across households while (Irawan et al. 2010) point out the importance of labor organization for the distribution of income and the impact on income inequality, a key factor in labor intensive plantations.

The distribution of benefits and costs differ over time and can be strongly influenced by government policies (Tassone et al. 2004), affecting cost and benefit distribution between stakeholders including timber, non-timber products, and environmental services (Wunder 2008). A wide range of stakeholders were indicated as being engaged in the value chain from plantation to consumer: seedling nurseries and civil society organizations supporting tree planting, community organizations mainly where workers reside and in villages adjacent to plantations and industrial operations and local governments. Stakeholders may continue to be suppliers or become competitors when plantations become mature and are harvested. Clients include direct household consumers (sawn timber, plywood, charcoal and furniture), small- and large-scale businesses (sawn timber, pallets and plywood) and governments (electricity poles). The importance of measuring perceptions of environmental and socio-economic impacts will call for quantitative data, for further studies. The impacts and management guided by international developed sustainable forest governance, and management guidelines reflect principles of accountability, effectiveness, efficiency, fairness/equity, participation of all interested people in decisions, transparency and availability of information about how the forest is governed, managed (Geraets & Natens 2014).

4.6.4 Positive social impacts

In terms of social impacts, plantation forests and agroforestry create and diversify employment in Ghana including in East Africa (Ingram et al. 2016). The Operation of forest Plantations on the local communities have been shown to provide skilled workers with stable jobs and improved salaries (Ingram et al. 2016).

Certification, responsible forestry and management can contribute to improved health and safety of employee working conditions, and access to social security, insurance and health care (Ingram et al. 2016) and for communities to access infrastructure such as schools, community halls, water wells, roads, and bridges established by companies in their communities (Ingram et al. 2016). Plantation forests provide a new product example poles, logs, moldings, charcoal, carbon credits, and increases the availability of wood fuel. This contributes considerably to countries' gross domestic product (Van Wilgen and Richardson 2012).

4.6.5 Negative social impact

Negative externalities to society include landowners, urban elites and middle classes, and capital-intensive industries tend to benefit most from plantations at the expense of indigenous groups living in and near forests. Plantations often bring about losses of customary tenure and access rights to resources, rural misunderstanding ,affect cultural burial grounds, and ancestral worship places (Lyons et al. 2014), which may create tension and conflicts. Thus, stakeholder dialogues and community engagement are paramount for conflict resolution (Ingram et al. 2016). According to Boakye (2015) despite the introduction of various reforestation schemes in Ghana, forest and tree resources do not adequately serve as reliable sources of livelihoods for forest-fringe communities. It can be argued that the Ghanaian forestry governance context (policies, laws, institutions) seems to hinder the potential of forest and tree schemes as reliable forest and tree-related livelihoods in the Ghanaian communities.

4.7 Benefits and cost analysis of forest plantation on the rural communities

The costs that are borne by society as a result of private decisions are called *social costs*. Social costs are incurred through two main ways: opportunity costs and external costs. When resources are used to produce forest products in plantation forestry, the same resources could have been used to produce other goods and services that are of benefit to society. Opportunity cost of using resources (inputs) in a way is the highest- value alternative use to the resource and if the use of resources in plantation forestry is not the best, then society is losing out, as their utility is not being maximized. When forest plantations are established on land, the same land has alternative uses, such as for rearing animals or producing food crops.

Also, the inputs such as labor and materials could have been employed in other uses as well. If an input has no alternative use, then its opportunity cost is zero, otherwise it has a positive opportunity cost, even if it is difficult to estimate. In a well-functioning and competitive market, the market price of an input is a good reflection of its opportunity cost. To use a concrete example, in undertaking economic analyses of a forest plantation, the opportunity cost of the land can be calculated by considering all other alternative uses of land and the benefits that could have been obtained if the land were put in food crops. The second type of social cost is external costs due to externalities. Externalities are side effects of the actions of economic agents, when the actions of one party impose costs on another party. They become negative impacts, but become a positive impact when the actions of one party benefit another party. For example, forest plantations produce timber, animals for meat production and game, if the production of the timber negatively affects the number of animals (in a situation where some animals die as a result of the timber production activities), then those who depend on the animals for their food are negatively impacted due to the actions of the forest manager. The killing of the animals by the timber production process imposes a cost on society that is not represented in the forest manager's production costs. In a perfect competitive market situation, the forest manager chooses to produce where the marginal cost equal marginal revenue.

4.8 Forest certification

There is market for goods or products from plantation that are certified for compliance with socio-economic and environmental quality. Furthermore, there is international market for new established forest plantations as moving concern if they are certified.

4.8.1 Forest Law Enforcement, Governance and Trade (FLEGT)

The FLEGT activity initiated by the European Union Action plan works through Voluntary Partnership Agreements (VPA). Ghana endorsed the VPA with the EU in 2009 with basic duty to the sustainable management of all types of forest, to give a legitimate system planned for guaranteeing that all timber item brought into the EU Community from Ghana secured by this Agreement have been lawfully delivered and in doing as such to advance exchange timber items. These associations will likewise encourage outsider accreditation forms. The Parties additionally concurred that to address the underlying drivers and drivers of unlawful logging, supplemental measures are required to reinforce segment administration and the lawful structure. Especially about handling the difficulties of developing local timber request, Ghana will attempt to embrace estimates, for example, plantation development, which in addition to expanding domestic wood supply will create opportunities for CDM and REDD+ initiatives.

The National Legal and Policy Framework, Ghana Shared Growth and Development Agenda (GSGDA) vol.II, perceives the need to reverse forest degradation and restore degraded landscapes through sustainable land management and intensification of the National Forest Plantation Development Programme (NDPC 2015). As a result of the importance the Government of Ghana attaches to forest plantation development, a number of strategies, policies and legislations have been introduced, in addition to funding a number of studies and projects since the mid 1990s, to provide direction and impetus for the development of forest plantations in Ghana. These include the following:

Policies and Legislations

I. Control and Prevention of Bushfires Act, 1990 (PNDC Law 229). (An Act to prohibit the starting of bushfires and to provide for related matters. It repealed the Bush Fire Law, 1983 (P.N.D.C.L. 46).

II. Ghana Investment Promotion Centre Act, 1994 (Act 478). (An Act to encourage, promote and facilitate investments into the country. It also supports measures that will enhance the investment climate in Ghana).

111. Forest Plantation Development Fund (FPDF) Act, 2000 (Act 583). (Provides financial assistance for the development of forest plantations; provides funds for research and technical advice).

IV. Forest Plantation Development Fund (Amendment) Act, 2002 (Act 623). (Sections (iii), (iv) and (v) support public and private investment in forest plantation development).

V. Forest Protection (Amendment) Act, 2002 (Act 624). (An Act to amend the Forest Protection Decree 1974 (NRCD 243) to provide for higher penalties for offences therein and to provide for related purposes.

4.9 Challenges faced by the forestry sector in Ghana

Despite an encouraging and a strong indication of steps towards sustainable forest management through policy and legislative changes, and international involvement, the forestry sector continues to face several challenges.

- Firstly, the most critical threat to Ghana's forestry sector is deforestation. Poor management of some forest reserves and off-reserve forests, increasing human population, uncontrolled wildfires, illegal logging, high dependence on wood energy, corruption, etc. all contribute to the high rates of forest cover loss in Ghana.

- Secondly, wood harvesting and processing continue to be inefficient, thereby leading to enormous waste in processing and destruction of residual forest stands. It is estimated that about 30 to 35% of the wood harvested are left in the forest as waste, while the conversion rate of logs into lumber is about 40% (Ibiyemi et al. 2019).

- Thirdly, the rising demand for wood products resulting from population growth will continue to pose challenges in terms of how to meet this demand from a diminishing forest resource base. In this case, improving efficiency of forest resource use, diversification towards value-added wood products, increasing wood supply through plantation development and the use of lesser-known tree species will be essential.

- Also, Ghana's timber products face high international competition from other tropical forest products, due to their elastic demand (Nanang 2010).The demand is also affected by the economic health of importing countries; hence fluctuations in the international business cycle partly drive export demand for Ghana's wood products.
- Furthermore, high poverty levels in Ghana in general and among forest fringe communities constitute a major stumbling block to sustainable forest management by making it difficult to control illegal forest product exploitation activities. Forest management strategies that ensure effective community participation will mitigate this problem.

- Last but not the least, a major challenge to the forestry sector in the competition between forestry and other land uses. Ghana is mainly an agricultural country, and hence expansion of agricultural cultivation, mining and urbanization into forests continue to contribute to deforestation and forest degradation.

5.0 Discussion

This section discusses the results of the study. It compares the results with reference to other researches that have been carried out on forest plantations within and outside the country. The discussions arrived at conclusions and make recommendations to aid policy formulation and further studies. In this literature review, the findings indicated that about 75% of Ghanaian people in the rural areas were poor. This provided a major reason for this review, so that we can assess the contribution of plantations forests to the wellbeing of society, particularly in rural areas. Keenan et al. (2015) report shows that forest and tree resources help reduce poverty and contribute to rural food security. Forest resources are therefore very important because it supplies basic needs and act as safety-net (Dwaf 2005).

Ghana has one of the highest rates of forest loss in Africa, raising concerns about the adverse consequences of diminishing forest cover and woodland areas in the country. The Modified Taungya System, which is currently being used in National Reforestation Projects in forest reserves, provides the population with some economic benefits and livelihood sources. Farmers are given rights to access the land, right to own food legally bound to own a proportion (40%) of the final income from the sales of the timber.

Despite all the benefits, the review also showed that the productivity of plantation sector is mainly destroyed by fires and other factors such as climatic factors, insects and diseases. Ghana's natural resources including flora, faunal populations, rivers and streams contribute immensely towards national development as well as urban and local livelihoods. These resources which spread across the high forest and savannah zones of the country are also declining due to deforestation and forest degradation and as a result, causing climate change. Community awareness or education should be intensified to prevent bush fires and other human activities. The traditional authorities should be empowered to prosecute offenders who destroy the forest plantations.

These and many other observations were observed that need further research to fully understand the socio-economic impacts of forest plantations on Ghanaian local communities.

6.0 Conclusion

Despite the challenges faced by forest plantations in Ghana, the sector contributes immensely to the social, economic and environmental needs of the society, particularly the rural communities. In view of the complex nature of forest management challenges faced the country, it must be emphasized that sustainability level may not be optimal at this time. Through the forestry development master plan, Ghana's forestry institutions had strengthened to be able to carry out the new task of offsetting exploitation of forest and wildlife resources and sustaining its forest products trade. Community education was created to ensure the involvement of local people. Forest Services Division train and equip local communities to monitor timber felling, processing, and conveyance of logs/lumber to market. The National Forest plantation Development Fund (NFPDF) should be streamlined to provide financial support to small-scale farmers and communities that want to established forest plantation. There was the need for continued flow of private investment into plantation forestry.

This is in recognition that the government alone cannot fund plantation forestry. This can only achieve if the government continues to ensure an atmosphere that promote private investments. It is recommended that further investigations into the effect of the National Forest Plantation projects on the income and food security of rural households should be carried out. Impact assessment of rural livelihoods could also be carried out thoroughly to ascertain the real contributions of the forest plantation projects on rural peoples' household income, food and formal education in the area. Finally, it was recommended that government, civil society and the private sector- join forces to stimulate the conservation of remaining forests.

7.0 References

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